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PHELPS'S ELECTRO-MOTOR PRINTING TELEGRAPH.*

In the summer of the year 1875, a new type-printing instrument was introduced upon the lines of the Western Union Telegraph Company between New York and Washington. This, like the well-known combination instrument, was the invention of Mr. George M. Phelps, and was the successful consummation of nearly ten years of thought and experiment, in which the inventor was materially aided by the cordial co-operation of the President and Electrician of the Western Union Telegraph Company. The practical results of nearly two years' continuous operation in actual service on the most important telegraphic route in the United States, have shown beyond a doubt that this invention is far in advance of any of its predecessors in respect to speed of transmission, ability to work over long lines, and freedom from derangement, to say nothing of its superior convenience and economy.

The type-wheel and printing mechanism of Mr. Phelps's instrument is operated by a rotary electro-magnetic engine, or electro-motor, which is set in action by a local battery. This improvement at once does away with a number of the and step-by-step movement. Like the Hughes apparatus, the transmitting apparatus and the type-wheel of the receiving instrument are caused to revolve synchronously under control of a governor, and each separate letter is printed by a single pulsation of the electric current of a determinate and uniform length, transmitted at a determinate time, but unlike the Hughes apparatus, the motion of the type-wheel is arrested while each letter is being printed, and is automatically released the instant the impression has been effected. Thus a speed of revolution may be given to the type-wheel in this instrument far greater than it would be possible to attain by means of a step-by-step movement, while at the same time letters which happen to come in direct sequence upon the key-board may be printed from during the same revolution. Owing to these features, it has been found possible for a skillful manipulator to attain a speed of transmission upon this instrument exceeding anything which has hitherto been regarded as possible. The various parts of the apparatus are mounted upon a heavy iron bed-plate, which is secured to a hard wood base about 18 inches by 23, as shown in Fig. 1, which is a perspective view of the instrument. The key-board is seen in front, and consists of twenty-eight keys, marked with the different letters of the neath being broken away in order to exhibit their relative arrangement more clearly. There are, of course, 28 of these slide-rods, and when any key is depressed, the corresponding slide-rod and its angular head is elevated. The manner in which the pulsations of the current are transmitted upon the depression of the keys is as follows:

In the centre of the hollow column A is a vertical shaft C, which is caused to revolve continuously at the rate of 240 revolutions per minute, by means of a hollow spur-wheel E, which receives its motion from the electro-motor by means of gearing, as will be hereafter explained. The speed with which this shaft revolves is controlled by a governor attached to the motor, and is almost absolutely uniform. Upon the shaft C is a hollow flanged collar B; this is not fixed rigidly to the shaft, but is loose upon it. As the collar and its attachments perform a very important function in the operation of the transmitting apparatus, it will be described in detail. It is shown in side elevation in Fig. 2; in inverted plan, or as it would appear viewed from beneath, in Fig. 3; in transverse vertical section in Fig. 5; and in plan or top view separately in Fig. 6. When none of the keys are depressed, the collar B revolves with the shaft C and wheel E, being coupled to them by the catch B_2 (Figs. 3 and 5), which

THE PHELPS ELECTRO-MOTOR PRINTING TELEGRAPH.—Fig. 1.

principal obstacles which have prevented the more general use of type-printing instruments. Thus in the Hughes instrument, which is driven by a heavy weight acting upon a train of wheel-work, the moving parts of the apparatus must necessarily be made very light, and this in turn gives rise to frequent breakages and derangements, while, on the other hand, in the combination instrument, in which the working parts are very strong and durable, the power required to propel the machinery is considerable, and if the work is at all continuous, renders it necessary to make use of a steam engine or other power, which is in most cases exceedingly inconvenient.

The Phelps apparatus, as now constructed, consists of the following principal parts:

1. The transmitting apparatus, consisting of the key-board and circuit-closing devices.
2. The receiving or printing mechanism.
3. The automatic unison mechanism.
4. The electro-motor and speed governor.

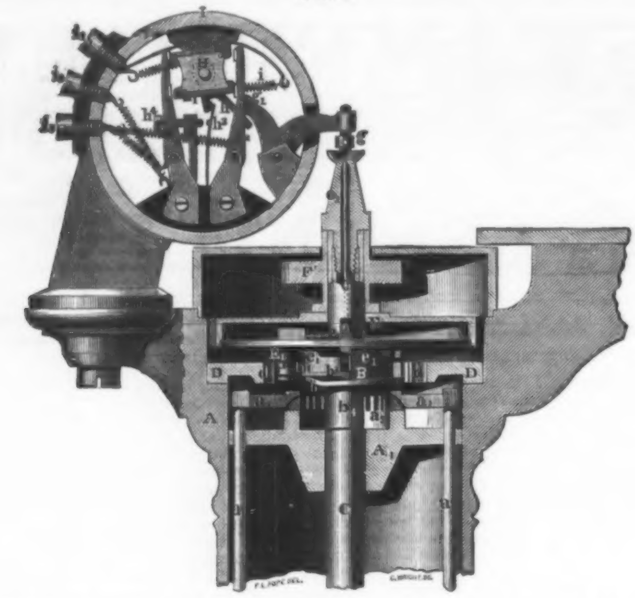
The principle upon which this instrument acts may perhaps be best described as a combination of the synochronous

* From advanced sheets of Prescott's "Electricity and the Electric Telegraph," now in press.

English alphabet, together with a period and space, or, as it is technically termed, a "dash key." The right hand white key is a blank key, and is not used. In the middle of the instrument, directly in the rear of the key-board, rises a hollow cylindrical column A, within which is a circular range of twenty-eight vertical slide-rods, one of which corresponds to each key of the key-board. The column A also contains the mechanism by which the circuit-closer is actuated. A transverse vertical section of the column A is shown in Fig. 2, which is exactly half of the actual size of the parts. The vertical slide rods are arranged as shown at a a, passing through guide apertures in the plate A_1 and a similar corresponding plate at the foot of the column. The connection of the keys with their respective slide-rods is effected by means of curved levers in the same manner as in the Hughes apparatus. The slide-rods a a are provided with angular heads a_1 a_1, which project towards the centre of the hollow column; their inner ends rest in slots formed in a guide ring a_2, which projects from the upper surface of the plate A_1. The inner ends of the heads a_1 a_1 form a compact circle about an inch and a half in diameter, as best seen by reference to Fig. 4, which is a horizontal section of the column A taken through the hollow spur-wheel E, some of the parts be-

is pressed by the spring B_3 (Fig. 4) into one of four shallow vertical grooves cut in the outer periphery of the Collar B. A dog B_1 is pivoted to the flange of the collar, and carries a sharp projection, b_1, which revolves almost in contact with a circle of 28 ratchet-shaped teeth d, formed on the inner edge of a stationary annular plate D (see Figs. 2 and 4). The tail b_2 of the dog B_1 extends through an opening into the interior of the drum, where it rests against a roller f mounted upon a spring f_1 (Figs. 3 and 6). The bottom of the collar B is formed into a flange or rim b, as seen in Fig. 3 (in which, however, a small portion of the flange is represented as being broken away in order to show the position of the catch B_2). The under surface of this flange is not exactly at right angles to the axis of the collar, but consists of two inclines, as best seen in Figs. 2 and 3, where b_3 represents one incline, which is short and sudden, while the other one is very gradual, and in the reverse direction, extending entirely around the remaining portion of the circle. The flange revolves with the collar of which it forms a part, in the direction indicated by the arrow in Fig. 3, being immediately above the inner ends of the angular heads of the slide-rods a a. Upon the top of the collar are four projections with bevelled corners, e_1 e_1 e_1 e_1 (Figs. 2 and 6), each of which oc-

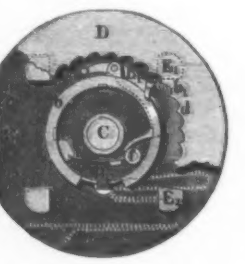
FIG. 2.



cupies one-eighth of its circumference. A horizontal pusher e mounted upon an arbor within the hollow wheel E, and which is shown in Figs. 2, 4 and 5, carries a short bevelled arm which extends downward and alongside of one of the projections e_1. The foot of a slender vertical rod c rests upon this lever, and extends upward through the hollow part c_1 of the shaft C, to the screw g. This rod c, when pushed upward, serves to actuate the circuit closer, as will be hereafter explained.

With the aid of the above description of the transmitting mechanism, it will now be possible to understand what takes place when one of the keys, for instance the dash, is depressed, the corresponding slide a is raised, and its angularly shaped head a_1 is pressed against the under surface of the flange b upon the collar B, which, together with the shaft C, is revolving at the rate of four revolutions per second in the

FIG. 3.

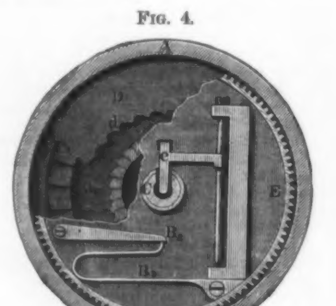


direction indicated by the arrow in Fig. 3. At the instant the incline b_2 passes over the elevated slide head, the sharp head b_1 of the dog B_1 is struck by it, and in consequence of its peculiar inclined form the dog is forced outward, and into contact with the opposite ratchet tooth d in the plate D, by which the rotation of the collar is instantly arrested at that point, although the shaft C and wheel E continue to revolve as before. This is permitted by the catch B_2, for the reason that the catch overcomes the pressure of the spring B_3 and slips out of its groove in the periphery of the collar. On the under side of the wheel E are four wedged-shaped cams E_1 E_2, etc. (Figs. 2 and 3), and after the shaft C and wheel E have moved through one-fourth of a revolution (the collar remaining stationary), the next succeeding cam strikes the head b_1 of the dog B_1 and forces it back into its original pocition freeing it from the stationary ratchet tooth in the plate D, while at the same instant the catch B_2 drops into the next succeeding groove in the collar B, which then revolves as before with the shaft C until it is arrested by the depression of another key.

The revolution of the wheel E and its attachments, while the collar remains stationary, causes the pusher e to be pressed upwards by the passing beneath it of one of the bevelled projections e_1 on the top of the collar, and thus the rod c is pushed upwards.

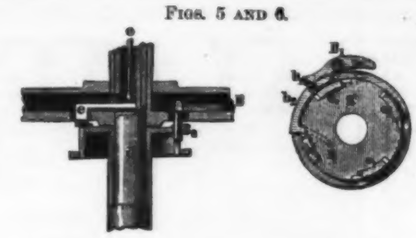
When, therefore, a key is depressed, no action takes place until the head of the dog B_1 in its revolution arrives at the corresponding slide-rod head, when the revolution of the collar B is instantly arrested during the time in which the shaft C is making one-fourth of a revolution, at the end of which

FIG. 4.



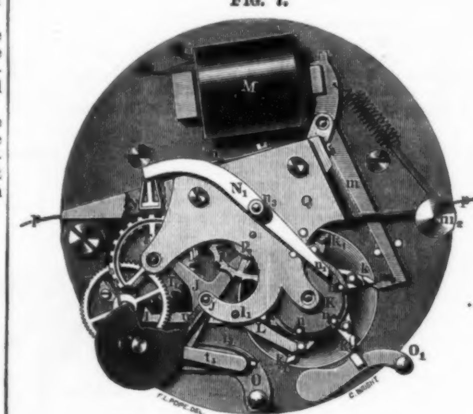
time it is again released by the automatic action of the mechanism as above explained, and permitted to revolve with the shaft as before. While the collar B is thus arrested the bevelled end of the pusher e passes over the projection e_1, raises the rod c within the hollow shaft, and operates the circuit-closer. As the shaft C makes four revolutions per second, it follows that the motion of the collar B is arrested for precisely one-sixteenth of a second by the depression of each key; and as the length of the projections e_1 which determine the length of time during which the rod c is elevated and the circuit closed, is one-eighth of the circumference of the collar, the duration of the electrical pulsation produced by the elevation of the rod c will be one-twenty-eighth of a second of time.

FIGS. 5 AND 6.



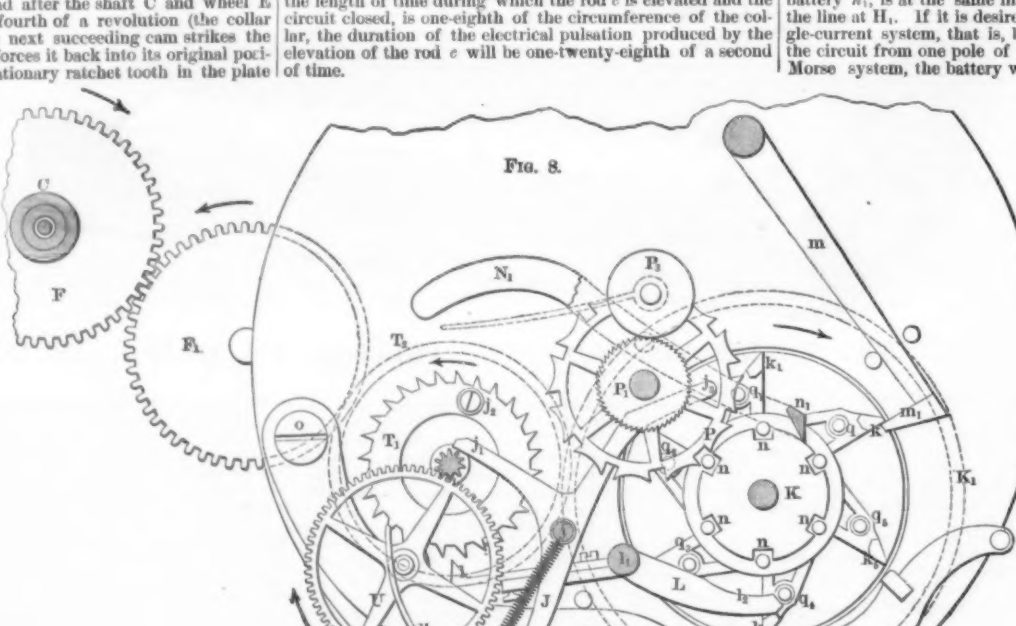
The circuit closing mechanism, as arranged by Mr. Phelps in his latest instruments, admits of either the single-current or the double-current system of transmission being employed, by merely changing the connections. This portion of the apparatus is enclosed in a cylindrical case I, fitted with plate glass heads. The arrangement of the parts is clearly shown in the sectional view, Fig. 2. H is a quadrangular plate of ivory mounted upon a horizontal rock-shaft, upon which is also rigidly fixed an arm h projecting downwards. Upon the upper and lower edges of the insulating plate H are fixed metallic bars h_1 h_2. A spiral spring attached to the insulated screw i_1 takes hold of a short arm projecting upward from the axis of H (the arm is not visible in the figure, being behind H). The tension of this spring keeps the arm h pressed against the friction roller g_1 upon the lever G, and the latter in turn presses downward by means of the adjustable screw g upon the vertical rod c. The spring also serves to conduct the electric current from the screw i_1, which is connected with the negative or zinc pole of the main battery, to the bar h_2. A second screw directly behind i_1 and insulated from it, is attached to the copper pole of the battery and is also connected by means of a curved wire and spring i to the metallic

FIG. 7.



bar h_1. Thus in effect h_1 is the positive and h_2 the negative pole of the main battery. H_1 and H_2 are two upright contact levers, which are connected respectively to the line wire and to the earth. The line wire is attached to the screw i_2 whence the connection is completed with the contact lever H_1 by means of a spiral spring which also serves to keep the latter pressed constantly against the bar h_2. Behind i_2 is another similar screw, to which the earth wire is attached, and connected by a spiral spring with H_2. Thus, when the apparatus is arranged for working by the double-current system, a negative current flows to line at all times when none of the keys are depressed, by way of i_1 h_2 H_1 and i_2. When, however, the rod c is raised by the action of the transmitting mechanism, the polarity of the current upon the line is reversed, for by the action of the lever G and roller g_1 upon the arm h the position of the plate H is shifted so as to bring the negative pole of the battery represented by h_2 into connection with the earth at H_2, while the positive pole of the battery h_1, is at the same instant put into connection with the line at H_1. If it is desired to work by means of the single-current system, that is, by simply making and breaking the circuit from one pole of the battery, as in the American Morse system, the battery wire is attached to the screw i_1

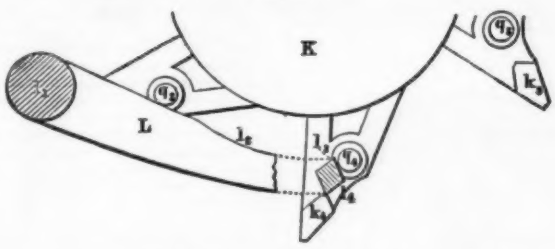
FIG. 8.



THE PHELPS ELECTRO-MOTOR PRINTING TELEGRAPH.

which connects by a spiral wire with the post which supports the adjustable contact screw h_1, while the line wire is connected with the contact spring h_2. Thus it will be understood that the raising of the rod c will cause the line current either to be reversed or to be closed for 1-28 of a second, each time a key is depressed, according as the apparatus is connected for double or for single currents.

FIG. 9.



The puisations thus transmitted are conducted through a relay connected with the sending as well as with the receiving instruments. With the double-current system a polarized relay is used, while for single currents an ordinary Morse relay serves an excellent purpose. The action of either relay upon the receiving portion of the apparatus is the same, inasmuch as its office is merely to close a local circuit in which is included the electro-magnet for controlling the action of the printing mechanism.

The printing mechanism is represented in the plan view, Fig. 7, while the outline drawing, Fig. 8 (which is of full size), shows more clearly the arrangement and mutual action of the different parts. These are compactly arranged upon a horizontal circular plate, which is supported by a bracket upon the hollow column A, at the right of the transmitting machinery. The type wheel T is rigidly fixed upon the same axis with, and directly above a wheel T_1 of the same diameter, which is provided with twenty-eight sharp ratchet shaped teeth, as shown in the figure. The wheels T and T_1 are upon a sleeve, and are attached by means of a friction plate to the axis of a toothed wheel T_2 (shown in dotted lines in Fig. 8 and also in the perspective view, Fig. 1), which receives its motion from the wheel F upon the shaft C, through the intervention of an idle wheel F_1. As the wheels F and T_2 have each the same number of teeth, they must necessarily revolve synchronously. The type wheel T is inked by means of the ink roller t (Fig. 7) which is mounted upon a horizontal swinging arm t_1, and is constantly pressed against the type wheel as it revolves, by the action of a spring t_2. In Fig. 7 the contiguous portions of the type wheel T and the ink roller t are represented as being broken away in order to exhibit some of the parts lying beneath.

The star shaped printing wheel K is perhaps the most important part of the entire printing mechanism. Under control of the electro-magnet M, it performs the fourfold office of arresting the type wheel at the proper point when a letter is to be printed; of forcing the platen and the paper into contact with the type thus presented, and instantly withdrawing it; of moving the paper forward the proper distance after the letter has been thus printed, and finally of releasing the type wheel after the printing has been effected. The printing whe l is carried by friction upon the vertical axis of a toothed wheel K_1, which receives its motion directly from the wheel T_2 upon the type wheel axis, as shown in Figs. 1 and 8. There are 58 teeth in the wheel T_2 and 98 in the wheel K_1, consequently the former makes a little more than one and one half revolutions to each one of the latter.

The electro-magnet M is actuated by a local battery connected with the receiving relay as before explained. To its armature is fixed the lever m, the latter being armed with a detent m_1, which takes hold of one of the points k of the printing wheel, whenever no current is passing through the magnet. The detent m_1, is kept in position by the tension of a spiral spring attached to the adjusting spindle m_2. The printing wheel K, being connected with the wheel K_2 by a frictional coupling, would revolve with the latter in the direction of the arrow, were it not held in check by the detent m_1.

The printing wheel K has six equidistant angular studs or pallets, k, k_1, k_2, etc., projecting from its circumference, which serve as stops upon which the detent m_1 successively acts. Two concentric rows of vertical pins are inserted in the upper surface of the printing wheel; there are six of these pins in each row. The outer row of pins q, q_1, q_2, q_3, q_4, q_5, act upon a stop lever which arrests the type wheel, while the inner row, n, n, n, act upon the platen at the proper moment for giving the impression, and also upon the mechanism for moving the paper.

The operation of printing a letter is as follows: When the detent m_1 is momentarily lifted by the action of the electro-magnet M upon its armature, the pallet k is released and the printing wheel K is carried forward one sixth of an entire revolution by reason of its frictional connection with the wheel K_1 beneath it. This movement of the printing wheel successively produces the following results: An angular projecting stud on the end of type wheel stop-lever L is caused to pass between the pallet k_4 and the pin q_4. As this lever turns upon a fulcrum at l_1 the detent l at its opposite extremity is instantly inserted between two teeth of the wheel T_1, and thus the revolution of the type wheel T (which is carried by friction from wheel T_2) is suddenly arrested at that point. The details of this portion of the mechanism will be best understood by reference to Fig. 9, which represents the parts enlarged to twice the actual dimensions. When the pin q_4 moves in the direction of the arrow, it bears against the inclined surface l_3 of the stop, and forces the lever L into a position by which the type wheel is locked. The lever is retained in this position by the pin as it glides along the curved surface l_2, thus holding the type wheel in check until the inclined face of the succeeding pallet k_5, coming in contact with the correspondingly inclined surface l_4 upon the lever L, returns the latter to its normal position, in readiness for the next repetition of the movement. Thus upon the release of the printing wheel K by the detent m_1 the type wheel is instantly arrested, held in check while the printing wheel makes one sixth of a revolution, and then released, the relative rate of motion of the type wheel and printing wheel, as determined by the gearing, being such that the type wheel is arrested for a length of time equal to precisely one fourth that occupied in making a complete revolution, or, in other words, for one sixteenth of a second. Its movements are, therefore, synchronous with those of the collar B of the transmitting apparatus, both in respect to its periods of motion and of rest.

During the time in which the type wheel is thus held in check by the stop lever L, the following movements take place, viz.: the inclined surface of the pallet n_1 on the end of the lever N_1 (Figs. 7 and 8), which lies in the path of one of the pins n, n, upon the wheel K, is struck by the pin, and thus the platen N, on the opposite end of the lever, is caused to press the paper strip p p momentarily against the opposite type upon the type wheel, from which it is again withdrawn by the action of the spring n_2 as soon as the pin n is free from the pallet n_1. The device for moving the paper forward is next brought into action. This is a modification of the mechanical movement known as the Geneva stop, the convex tooth being omitted. One of the row of pins, n, n, etc., (See Fig. 8), enters into one of the twelve notches in the periphery of the wheel P and carries it forward one twelfth of a revolution. Upon the axis of the wheel P is a roller P_1 with a fine milled edge, against which presses a jockey roller P_2 mounted upon a spring. The paper strip p p is fed from a continuous roll, and passes through suitable guides in the frame Q between the rollers P_1 and P_2, by the movement of which it is carried forward the proper distance after the impression of each letter has been made.

It now remains to describe the automatic unison mechanism, which is one of the most interesting of the minor accessories of the Phelps apparatus. In all type printing systems it is of course necessary that the transmitting mechanism of one instrument and the type wheel of the other should be in exact correspondence, and to effect this some means must be employed to ensure their starting together. In the Hughes and combination instruments this is accomplished by a simple stop lever, which takes hold of a stud upon the type wheel whenever it is tnrown into the path of the latter by the receiving operator. The first movement of the printing mechanism releases the type wheel, which starts from the dash or space. It is, therefore, only requisite that the transmitting operator should release the type wheel by first touching the dash key, and the other letters of the alphabet will necessarily fall into their proper relation. In Mr. Phelps's instrument an improvement is added by which the type wheel is automatically arrested at the dash or zero point, whenever it is permitted to make a few revolutions without printing. Upon the upper surface of the wheel T_1 (Fig. 8), directly under the type wheel, is a pin j_2, which is filed to a flat surface on the side towards which the wheel itself revolves, as indicated by the arrow. J is a three armed stop lever, turning upon a fulcrum j. U is a toothed wheel mounted so as to revolve freely upon a pin fixed in the horizontal lever O, by moving which it may be thrown in or out of gear with a corresponding pinion on the type wheel axis, at the pleasure of the operator. Ordinarily it is kept in gear with the pinion, and receives therefrom a slow rotary motion in the direction indicated by the arrow. A curved arm u, pivoted to the arm j_4 of the stop lever J, is constantly pressed against the revolving axis of the wheel U by the tension of the spiral spring U_1. The friction between the axis of the wheel U and the curved arm u has the effect of slowly but continually swinging the stop lever J around towards the left whenever the type wheel is in motion. If the printing wheel K meantime continues stationary, in the course of four or five revolutions of the type wheel the lever J will be swung around into such a position that a stop which projects downward from the end of the arm J_1 of the stop lever will be thrown into the path of the stop j_2 upon the wheel T_1, which latter will come in contact with it in its next revolution; the type wheel will thus be arrested with its dash or blank space opposite the platen, in which position it will remain until the printing mechanism is again operated. The instant, however, that the printing wheel K is released by the action of the electro-magnet, the stop lever J is thrown back into the position shown in Fig. 8, because its third arm j_3 now lies directly in the path of the pin q_3 upon the printing wheel. So long as one or more letters are printed at every revolution of the type wheel, a continual succession of pins will strike against the arm j_3 and prevent the stop lever J from being swung around far enough to arrest the type wheel, unless the operation of printing be suspended during several successive revolutions of the type wheel axis, when the type wheel will be automatically arrested, as before explained.—*Journal of the Telegraph.*

FAST TELEGRAPHY.

The President's message, which this year contained about 7,100 words, was transmitted by the Western Union Telegraph Co., from Washington to New York, dropping copies at Baltimore and Philadelphia, in twenty-eight minutes, without a stop or error. Ten wires were used. In less than two hours from the time it was filed at Washington, the Message in full was in the hands of the press in every important town in the country, without any disarrangement whatever to the ordinary business of the company. So much for good system and superior facilities.

A NEW ELECTRIC LAMP.

By M. P. JABLOSCHKOFF.

The new source of light is composed of two pieces of charcoal fixed in a parallel position at a little distance from each other, and separated by an insulating substance capable of wasting away at the same speed as the charcoal. When the electric current begins to pass the voltaic arc is formed between the two uncovered extremities of the two charcoals. The nearest layer of the insulating matter melts, if volatilized, and slowly lays bare the two rods of charcoal just as the wax of a candle progressively uncovers its wick as the combustion is propagated downwards. The heat springing from the combustion of the charcoal is utilized for the fusion and votalization of the insulating mixture The composition of this latter may be varied indefinitely, since most earthy matters may be employed. The simplest mixture provisionally adopted consists of sand and powdered glass, which with an equal electric power gives double the light of a regulator. The author has been able to divide the light produced by a single source of the current. With a single Gramme machine of the common make he has caused three sets of charcoals to burn at once.

RAW HIDE TIPS.

TO THE EDITOR OF THE SCIENTIFIC AMERICAN:

In your supplement for November 11th, 1876, No. 46, is an article headed "Raw Hide Tips, by J. A. Stockwell." I did not write the article in question, or authorize it or know anything of it. I am not an inventor of a so-called raw hide tip, which is a conflicting if not an infringing tip upon my several patents for a leather tip, and which are well known in the market as the "Stockwell Shoe Tip."

You, therefore, cannot fail to see the injustice done me in the use of my name as an endorsement of a tip which I re. gard as of little value at the expense of my own invention. If you have been imposed upon, you can readily see the mo tive as well as the injustice done me, and I respectfully re quest you to correct this error or worse.

J. A. STOCKWELL.

Boston, Mass

EXTENSION OF THE METROPOLITAN UNDERGROUND RAILWAY, LONDON.

"Commenced, March 1st, 1876." "Completed, November —, 1876," is the simple inscription that heads the marble tablet in the Aldgate Station, now standing at the end of the finishing link, in the scheme of the Metropolitan Underground Railways. These few words, tell us that in nine months has one of the most difficult and most costly pieces of railway in the world been begun and finished. Though only about thirty-seven chains in length, almost every yard of its course was attended with extraordinary difficulties. Nine main sewers had to be cut and diverted, and their flow provided for while the diversions were being effected, the new portions being built as syphons, dipping a small distance below the rails. One large sewer, 5ft. by 3ft. inside, the company were compelled to build at a depth of 10ft. under, and for the whole length of the line, a work which, considering the depth at which it is built below the surface, and the enormous weights above it, was not much exceeded in difficulty and responsibility by that of the railway tunnel itself. Scarcely less formidable was the work of under-pinning and supporting the various heavy buildings along the route, and more especially the great warehouses of the St. Katherine's Company, the walls of which are 86ft. high and 4ft. in thickness. The foundations under these in the neighbourhood of the line had to be rebuilt, and in some parts carried to a great depth, so as to get the very sound footing necessary under such massive structures. The greatest depth of the rails below the surface is about 28ft. near the new station, and about 17ft. on the greater part of the line, the average thickness of earth above the tunnel being about 6ft. The line runs almost level throughout on a curve of 2000ft. radius, extending between the two stations The permanent way is of the strongest description, laid with steel rails of very heavy section, viz., 86 lb. per yard. Saxby and Farmer's interlocking signals and Spagnoletti's block telegraph instruments are employed, and locking bars are fitted to the facing points. In the new station there are four lines of rails with two platforms. The roofs over these are, for about half their length, flats covered with zinc, and supported upon two rows of cast iron columns in the central portion of the platform, the width of the roofs slightly exceeding that of the platforms.

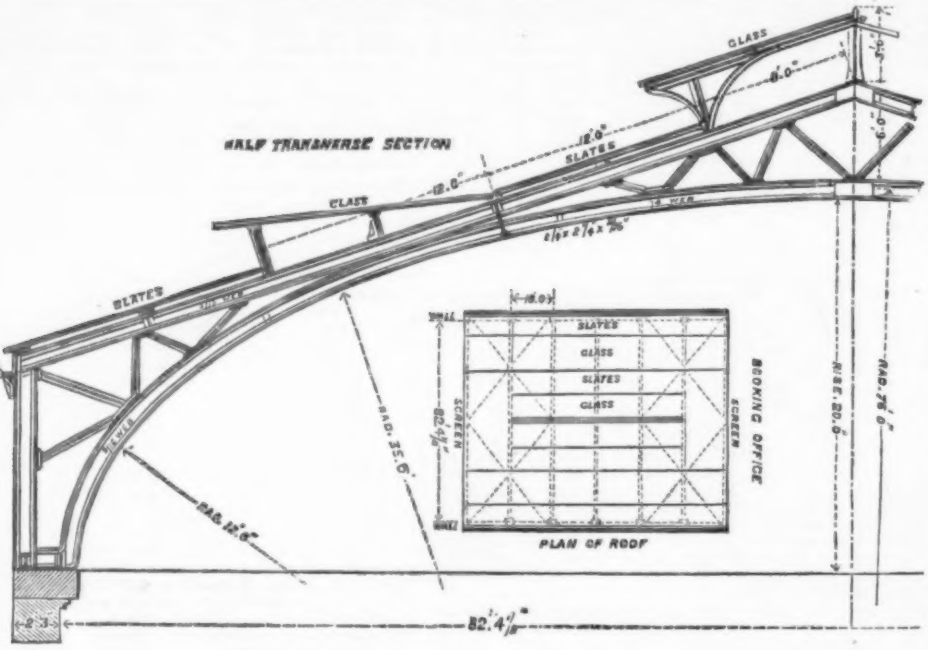
The main roof, of which we give a sectional elevation, springs from the bounding walls of the station, and covers half the length of the platforms. It will be seen that the principals are of a graceful design, and though similar in character to those of the new roof over the Liverpool street station of the Great Eastern Railway, are an improvement upon these, which were perhaps the most pleasing design in London. A space of about 5ft. exists between the springing of the roof and the walls, so that the station is well ventilated; and as the commencement of the tunnel is about 200 yards from the booking-office, the ventilation is superior to almost all on the Metropolitan Railway. Concrete has been used exclusively in the building of the retaining walls on each side of the open cutting, and as they are from 20ft. to 28ft. above the line, they are necessarily of great strength. Above the ground surface they are, however, carried up a few feet in brick.

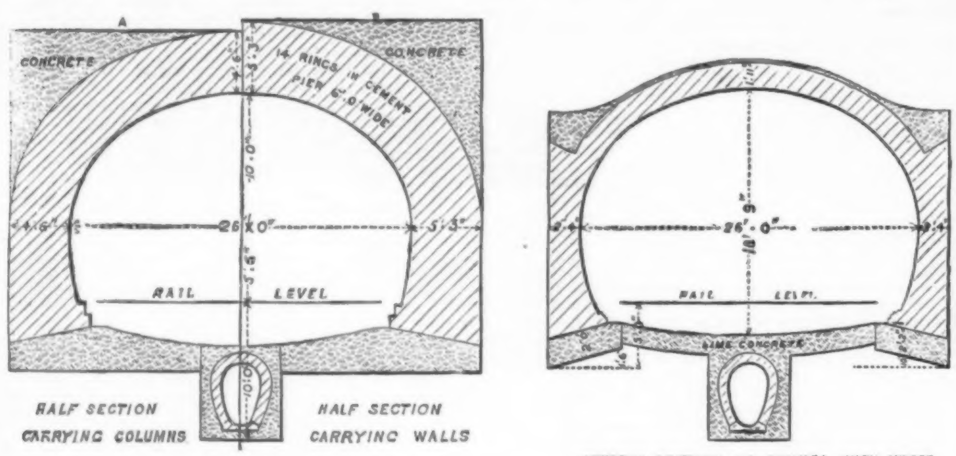
The architecture of the station is of a simple character, and the roof of the booking-office is of open quadrilateral queen-post framework, the covering being of deal boards, and the whole varnished. The lapse of a year or two will perhaps alter the appearance of this woodwork, but at present the boarding especially has a dirty varnished appearance. Only really first-class wood will look well varnished in this manner; common deal boards, especially those with any sap-wood remaining on their edges, look always like dirty boards washed to receive a shining exterior of varnish.

The approach from the booking-office is by means of a gallery platform attached to the inner wall of the booking-office, and extending from one retaining wall to the other. From this gallery the platforms proper are reached by means of two broad flights of steps, which are covered with Hawksley's patent wood cubes set in cast iron frames, forming the treads. The engine-pits are under the booking-office, the latter being supported on heavy cast iron columns and wrought iron plate girders.

The chief point in the explanation of the rapidity with which this work has been executed is the fact that the company became fully possessed of all the property required for the work before any commencement whatever on the spot was made, everything being thus clear for the engineers and contractors to proceed without any of the annoying hindrances, the removal of which is not within the province of the engineer. Considering the limited space at disposal, it would seem that an excellent terminus has been obtained, and one which will probably meet the very great traffic which will, it is expected, pass over this piece of line. As this extension will tap the general traffic of the whole of the eastern part of the city and the East-end of London, the docks, Fenchurch street, and all the small but important streets therefrom, as well as Whitechapel and Commercial road, the prediction as to profitable results, in spite of its great cost, can hardly fail to be realized. It must be remembered, however, by the company, that their line is already often crowded to the very great inconvenience of their customers, so that new train arrangements will have to be made to meet the expected increase of traffic from the new line.

The proposition to continue the line eastward to Tower hill, then to turn round by Postern row to Eastcheap, and finally to effect a junction at the Mansion House Station with





HALF SECTION CARRYING COLUMNS

HALF SECTION CARRYING WALLS

GENERAL SECTION OF TUNNEL WITH INVERT

THE UNDERGROUND RAILWAY, LONDON. THE RECENT EXTENSION.

the District Company's line, was abandoned two years ago by the Inner Circle Completion Company ; but a company is still in existence, having powers, whenever they see their way to raise the necessary capital, for constructing the connecting link in a modified form. They propose to join the Metropolitan just outside the new Aldgate Station, proceed direct to Fenchurch street, which they undertake to widen, then under King William street, passing close by the statue of William the Fourth, and then directly along Canon street to the point of junction with the line of the Metropolitan District Company. The enormous value of the property along this last remaining link may make any company hesitate before commencing so formidable an undertaking ; but the immense increase of traffic within the Metropolis is a sufficient guarantee that it will one day be carried out.

The marble tablet in the Aldgate Station, to which we have referred, records the fact that the last extension of the Metropolitan Railway was commenced on the 1st March, 1876, and gives the names of Sir Edward Watkin, chairman of the company, and his fellow directors ; the general manager, Mr. Myles Fenton ; Mr. F. Brady, the engineer ; and Messrs. Lucas and Aird, contractors ; and the blank yet left for the day when the line is completed in every respect and opened for general traffic, it was expected would be filled up not later than the 1st of Dec. last, when the through service of trains was to commence running.

On Monday Colonel Yolland inspected and approved the new line, and a service of trains will be run at frequent intervals between these two stations on and after Saturday next.

We are enabled, by the courtesy of Mr. Francis Brady, C.E., and of Mr. Myles Fenton, to give illustrations of the roof over the station and sections of the tunnel. The semi-transverse section of the roof, owing to the simplicity of its design, needs no more explanation than is conveyed by the figure. The advantages of the straight rafter roof, upon which we dwelt in our impression on the 4th and 11th August last, and the pleasing effect of a graceful curve to the inner member of the principals are, it will be seen, combined in an effective manner. The plan of the roof shows the distance between the principals, the staying between these, and the respective areas covered with glass and slates. The purlines, supporting the skylight (shown in section), are light lattice girders, and those supporting the slated portion of the roof are light angle and plate beams, covered with a wood cap. The general section of the tunnel and invert, and the section under the great tea warehouses, require little explanation. The latter section is taken through the strengthening rings of large dimensions at this place, the half A of the figure being built under the columns in the warehouse, and the other half B showing the enormous strength deemed necessary to carry the outer warehouse walls. The invert is also shown in both sections.—*The Engineer.*

MACHINE FOR STRAIGHTENING RAILROAD RAILS.

By W. B. Chisholm, J. Walker, and E. Martin, of Cleveland, Ohio.

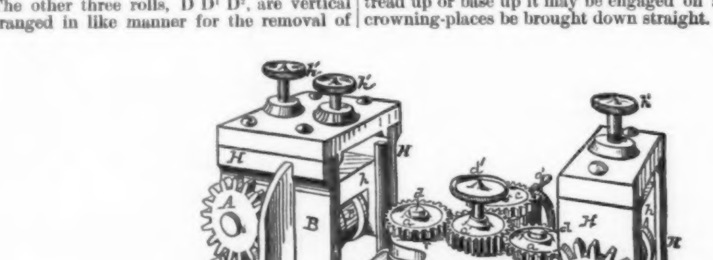
In our machine, as shown, we employ nine rolls, of which six are horizontal and three vertical. Of the horizontal rolls four, arranged in pairs, A A^1 and A^2 A^3, are, alternately, feed and delivery rolls. One of these rolls, A^1, along with the other two horizontal rolls B B^1, constitute one set of straightening rolls, and are arranged in accordance with well-known laws for the removal of vertical curves or bends in the rail *z*. The other three rolls, D D^1 D^2, are vertical rolls, and are arranged in like manner for the removal of lateral curves, bends, or deflections. The action of a series of three rolls thus arranged is so well known as not to require a further description. The rolls A A^1 A^2 A^3 B are mounted in bearing blocks or frames, *h*, in housings H, of any suitable construction, and the upper ones are vertically adjustable in the usual way, and for the usual purposes, by means of any desired arrangement of adjusting-screws h'. The feed and delivery rolls A A^1 A^2 A^3 are geared to run by a common positive motion, imparted to them through a driving-shaft, *b*, and lines of gearing and shafting b^1 b^2 b^3 g g'. The shafts b^3 are, for convenience, prolongations of the necks of the rolls A^1 A^3, or, if the roll-bodies are made separate, they are secured on the same shafts. The pinions g g' are so shaped as to mesh and operate at all points within the limits of the necessary adjustments of the upper rolls A A^2. The rolls B B' run by frictional contact with the rail passing through.

Between the end rolls thus described, and on the base or foundation W of the machine, we fix on opposite sides of the line of feed a pair of rest-blocks, P, with over-projecting lips P^1 and vertical posts P^2. In one of these we arrange the base-plate R' of an adjustable sliding frame, R, having its inner end boxed out, and having the inner side of the box open, as shown in the engravings. The upper and lower sides of the box are elongated, so as to form bearings *r r* for the shafts *d d*, on which the rolls D D^2 are loosely arranged—that is, are arranged so that the rolls may revolve independently of their shafts. These shafts are made with screw-threads at their upper ends, as shown in Fig. 5, and such threaded parts of the shafts play through tapped nuts fixedly set or secured on or in the upper bearings *r*. Above the bearings the shafts are made long enough for adjusting pinions *a* to be secured thereto. Mounted on the same box is the intermediate pinion a^1, operated by the hand-wheel a^2. The frame R, carrying with it the rolls D D^2, is adjusted to and from the line of feed by an adjusting-screw, *p*. On the other side of the line of feed, and in the other rest-block P, we arrange the like base-plate S^1 of a like adjustable sliding frame, S, boxed out, and with its inner end open in like manner, as already described with reference to the frame R, and is also illustrated in the engravings. The upper and lower parts or sides of this box form bearings *s s* for the shaft d^1, on which the third vertical roll D^1 is loosely arranged, as before described. And the upper end of this shaft is in like manner threaded, Fig. 5, and the threaded part plays in a tapped nut securely set in or on the upper bearing *s*. On the upper end of this shaft is secured the pinion *c*. This frame S, with its roller D^1, is also adjustable to and from the line of feed by an adjusting-screw, *q*, and, as the chief lateral adjustment is intended to be secured by varying the position of this single roll, we add a crank, q^1, for ease and facility in effecting the desired lateral adjustment.

The pinions *a*, *a*, and *c*, all mesh into the intermediate pinion a^1, and the teeth of these pinions particularly of a^1 and *c*, are preferably so shaped that they will mesh at all times within the necessary limits of the lateral adjustments of the vertical rolls to and from each other. Also the intermediate pinion a^1 is made with teeth of such length as to be adapted to engage the teeth of the pinions *a a c* at all points of the necessary vertical adjustments of the rolls D D^1 D^2.

The horizontal rolls are, preferably, grooved, as shown, and the vertical rolls necessarily so, or, at least, made of different diameters in different parts, the depth of the groove, or the difference in diameter, being equal in each roll to one-half of the difference between the breadth of the base and the tread of the rail. Such differences of diameter will vary with the irregular shape of the bar to be straightened ; and to this end the faces of the rolls may have any of the forms known in iron-rolling or included under the term "moldings."

Our invention is more particularly designed to enable rails to be inverted for passing through the machine, as well as to be run through with the tread up, so that going through tread up or base up it may be engaged on all sides, and all crowning-places be brought down straight.



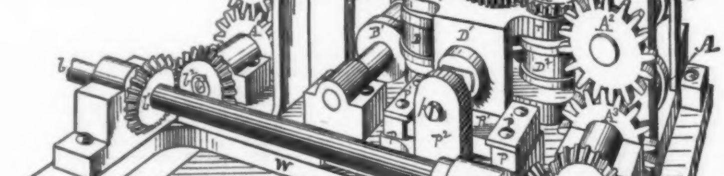


Fig. 2

MACHINE FOR STRAIGHTENING RAILWAY RAILS.

NEW NARROW-GAUGE LOCOMOTIVE.

The illustration shown is from a photograph of a new class of engines for the Indian States Railways, of which twenty have been built by the Vulcan Foundry Company, Limited, Newton-le-Willows, Lancashire, England.

The principal dimensions of these engines are as follows, viz:—Gauge of railway, 3 ft. 3⅜ in., or what is generally known under the designation of metre gauge; diameter of cylinders, 11½ in. by 17 in. stroke; wheel base of engines, 11 ft. 3 in.; ditto of tender, 7 ft. 6 in.; extreme wheel base, 25 ft. 4 in.; diameter of boiler, inside, 3 ft. 1⅛ in.; length of boiler, 7 ft. 10 in.; length of fire-box, inside, at top, 3 ft. 2¼ in.; breadth of ditto, at top, 2 ft. 5¼ in.; number of tubes, 16; outside diameter of ditto, 1¾ in.; length, 8 ft 3½ in.; superficial area of tubes, 398·5 square feet; superficial area of fire-box, equal to 45·75 square feet, or a total heating surface of 444·25 square feet; area of fire-grate, 6·9 square feet; distance between frames, 2 ft. 9¼ in.; diameter of leading and driving wheels, 3 ft.; diameter of trailing and tender wheels, 2 ft. 1½ in.; capacity of tender tank, 800 gallons; fuel space, equal to 64 cubic feet.

The principal points of interest in connection with the specified details are as follows: All the valves throughout, and cocks are fitted with stuffing boxes and glands for ordinary packing; the axle boxes are of cast-iron in two parts, the gun-metal bearing being a circular flanged bush.

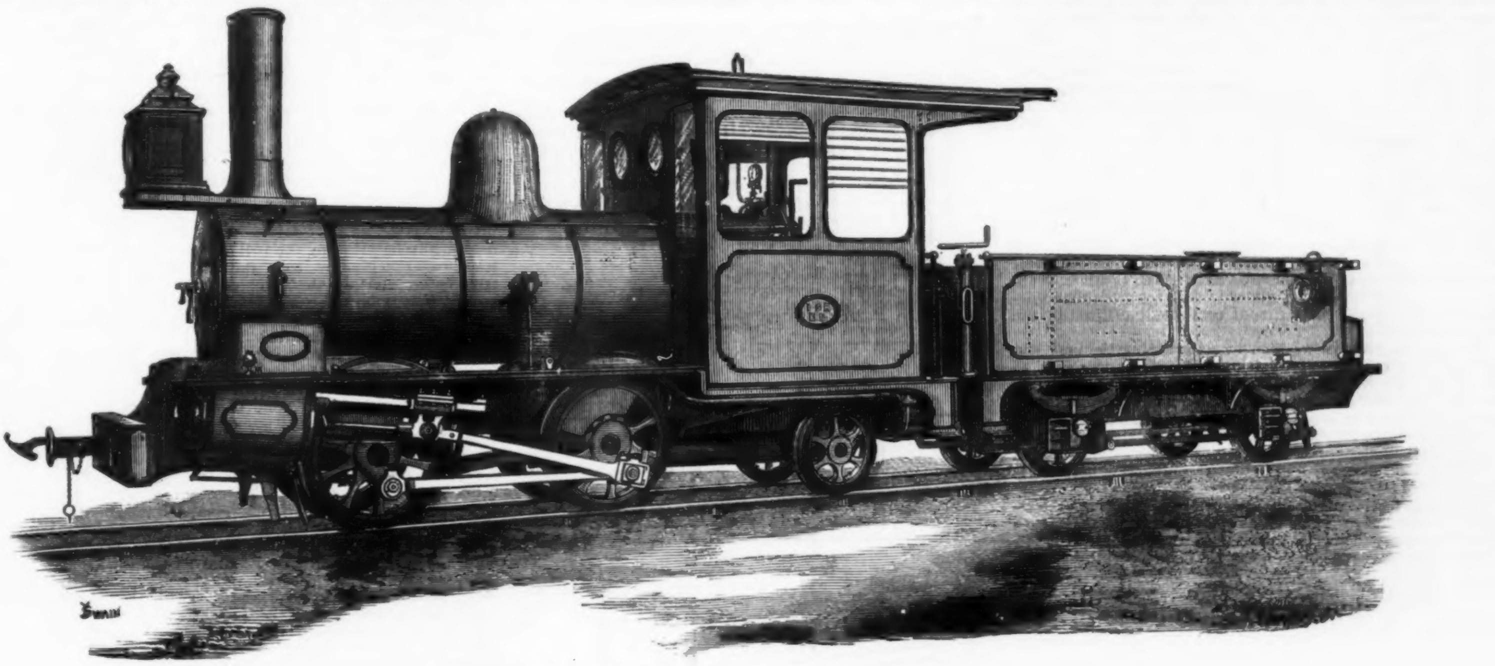
The boiler is supplied by two injectors, Friedmann's patent, No. 6 size.

The cylinders were tested by hydraulic pressure to 250 lbs. per square inch; the tender tanks to 3 lb. per square inch; the boiler tests, hydraulic 200 lb., and steam to 140 lb.

The awning cab has been made as commodious and airy as possible, and on either side is a door, the upper part of which is glazed with thick plate glass.

With the view of facilitating the replacement of details, the principle of duplicates has been carried out to the fullest extent; even the cylinders are so arranged that they are adapted for either right or left hand side.

These engines, which we understand are intended for British Burmah, are designed in accordance with specifications supplied by Mr. A. M. Rendel, C. E.—*The Engineer.*

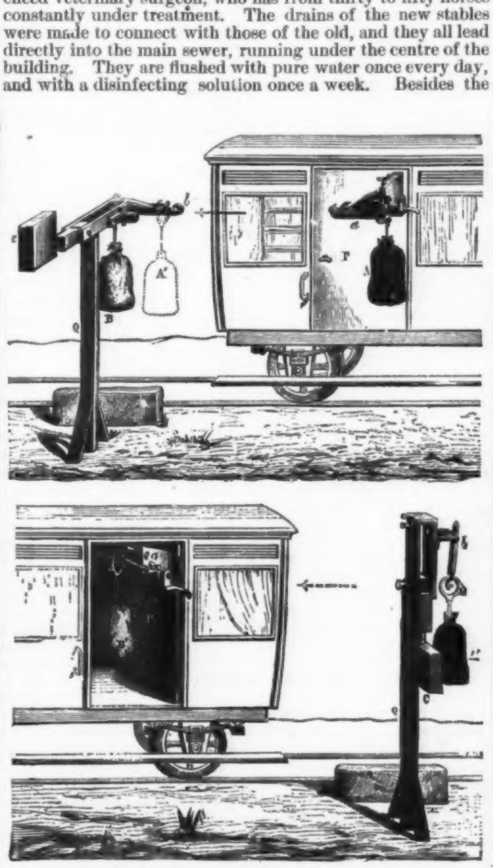


NEW NARROW-GAUGE LOCOMOTIVE.

FRENCH MAIL BAG CATCHER.

SEVERAL devices are in use on railroads in this country whereby fast mail trains are enabled to pick up mail bags at way stations automatically, and without stopping. The American system has been introduced in France. We extract from *La Nature* the annexed engraving of the invention by M. Calheleux, whereby the mail bag is not only siezed as the train passes, but the bag containing the letters, etc., for the station, is left in its place.

Fig. 1 represents the apparatus ready for action, and Fig. 2 shows its position after the exchange has been effected. In Fig. 1 the door of the car, which opens in the direction of the arrow, is closed, and the mail bag, A, hangs outside ready to be delivered. The bag, B, to be taken up, is suspended on a counterweighted arm, held horizontal by a spring catch. The bags are attached to rings. As the train passes, the spring hook, *a*, on the door enters the ring of bag B, and the similar hook, *b*, on the arm passes through the ring of bag A. Both bags are thus simultaneously lifted from their supports, and the springs on the catching hooks prevent them from slipping off. At the same time the arms respectively push stops, one of which frees a counterweight which pulls open the sliding door of the car, so that another spring can swing the hook, which carries the bag taken up inward; while the other stop releases the catch on the arm, so that the counterweight falls, thus carrying the bag inward. The position of the various portions is thus as in Fig. 2. It is stated that this apparatus has worked successfully on trains travelling at the rate of 40 miles per hour.



THE FRENCH POSTAL SERVICE.—THE RAILWAY MAIL BAG CATCHER.

A MODEL CAR STABLE.

The stables of the City Line of the New York and Harlem Railroad Company, to which a large and important addition has just been made under the direction of the Vice President, Mr. William H. Vanderbilt, are now second to none in the world in point of ventilation and cleanliness. The old stables, which occupy the lower or basement floor of the large depot of the Company, on Fourth avenue, between Thirty-second and Thirty-third streets, were some months ago found to be insufficient for the additional number of horses required by the increased traffic of the line, and it was, therefore, decided that an addition should be built. The execution of the design was intrusted to Mr. J. B. Snooks, the architect of the Company, and under his supervision a large brick building, 182 feet long by 172 feet wide, and two stories high, was erected on the south-east corner of the block occupied by the depot, which now covers the whole space inclosed by Fourth and Lexington avenues and Thirty-second and Thirty-third streets. On the basement or ground floor of this building 273 stalls were put up and are now occupied by the horses. On the floor above there is room for a like number of stalls, but as they are not needed at present the space is left vacant. The top floor of the building is reserved for the storage of grain and hay. A blacksmith's shop has also been fitted up in the new building. It contains eight patent forges, and employs fourteen men—two jobbers and twelve shoers—the latter fitting on about 200 new shoes per day. The hospital for lame and disabled horses is also in the new building, and has room for seventy-five animals. It is in charge of an experienced veterinary surgeon, who has from thirty to fifty horses constantly under treatment. The drains of the new stables were made to connect with those of the old, and they all lead directly into the main sewer, running under the centre of the building. They are flushed with pure water once every day, and with a disinfecting solution once a week. Besides the large windows and doors opening into the gangways between the stalls, large ventilating flues, running to the top of the building, are placed at intervals of ten feet around the walls. With these appliances it is found that the atmosphere can always be kept pure and free from disagreeable odors. Besides the improvements and repairs mentioned all the other departments of the depot have received a thorough overhauling, and are now in perfect running order. In the stables, including the recent addition, there are now 906 stalls, all on the same floor, of which 827 are occupied. The main floor of the depot, which is used as a car house, has room for 120 cars. Of these the company now has 116, of which eighty-nine are now running. There are fourteen blacksmiths, twelve carpenters, four harness-makers, two engineers, and about one hundred hostlers and stable men constantly employed about the depot. The entire cost of the improvement and repairs was a little over $150,000.—*N. Y. Times.*

REMOVAL OF LEAD FROM THE HUMAN SYSTEM BY ELECTRICITY.

IN a late number of the London *Lancet* a somewhat singular case of cumulative lead-poisoning is reported, which tends to show that early rising has its pains and penalties as well as its profits and pleasures. A cab-washer who was in the habit of drinking deeply during the day, and of sleeping in an omnibus until the time came for him to wash forty cabs, was brought into St. Mary's Hospital, in February, 1875, suffering from phthisis and delirium tremens. He recovered from the latter complaint and got better of the former, but it was found that he had completely lost the use of his upper extremities, while his voice was reduced to the merest whisper. On being questioned he stated that, as he usually finished his work just as the public-houses opened, he always had the very first glass of beer or gin that was served in the morning; that is to say, the liquor which had remained all night in the drawpipe in contact with the lead. His gums showed the well-known blue line indicative of lead poisoning, and other confirmatory symptoms existed which need not be detailed here. His urine gave 1-3400th of a grain of lead per fluid ounce, and some of the gin which he drank every morning having been procured and tested gave 1-430th of a grain per fluid ounce. From the beginning of June to the beginning of December he was treated with iodide of potassium in large doses, and was galvanized and faradised daily, but all to no purpose. Mr. S. J. Knott, M.R.C.S., the medical superintendent of galvanism at St. Mary's Hospital, suggested that a thorough trial of galvanic baths should be made on the patient. Accordingly, on December 4th, he was placed in a warm bath, and the water charged with twenty-eight cells of a voltaic battery. At first the current was passed from the positive pole, placed at the nape of the neck, to the negative, which was placed at the feet. After ten minutes the negative pole was moved along his legs and arms for twenty minutes more. The treatment was continued daily, and at the end of a fortnight he was so much better as to be able to raise his arms fairly, and flex them pretty well. From this time he continued to mend, the baths being still kept up three times a week, and finally returned to his work in February. The fourth bath was acidulated and tested by Dr. Handfield Jones, who found well-marked traces of lead in it, which were absent in the water supplied to the bath. If lead can be thus eliminated from the body by the electric current, why not arsenic, mercury, and silver? In ordinary cases of lead cholic and dropped wrists the electric bath has proved efficacious in a few days without any medicine. If this method of administering electricity be equally efficacious in other cases of plumbism as in those treated by Mr. Knott, medicine will have to thank physical science for putting into her hands an additional weapon for counteracting human disorders.

THE TALLEST LIGHTHOUSE IN THE WORLD.

The firm of Cail & Co. have begun the construction of the great lighthouse which is to stand on the brow of the Trocadero, in Paris, during the great Exhibition of 1878. The lighthouse in the 1867 Exhibition was only 53 metres (180 ft.) high, whereas the present one will reach 127 metres, or 413 ft., in height. The lighthouse has been ordered for Plymouth, and its white and red lights will be seen seven leagues on the main. It will contain ten rooms for attendants, two provision bunkers, an infirmary, and a bedroom with ten beds for the shipwrecked. About 50 metres (162 ft.) above the level of the sea a movable annular plate is provided, carrying a big cannon for shooting the salvage line within a range of 8,000 to 10,000 metres. Near the base of this gigantic pharos there is a complete and improved lifeboat arrangement, which allows of a lifeboat being lowered by one man.

SIDERAPHTHITE, A NEW ALLOY.

This is composed of 65 parts iron, 23 nickel, 4 tungsten, 5 aluminium, 5 copper. It resists sulphuretted hydrogen, is not attacked by vegetable acids, and only slightly by mineral acids. It is really more useful than standard silver, while it can be produced at a cost not exceeding that of German silver. For alloys which have to be silver-plated to prevent oxidation, the inoxidisable iron, as the above is called, is stated to be a perfectly successful substitute.

WATER GAS AS A FUEL.

By G. S. DWIGHT.

Although scientists have heretofore admitted that there were undoubtedly great possibilities involved in the gaseous products of water, the failure to produce them on a practical scale must account for the fact that little has been said or known of their high comparative value.

The recent successful production of water gas in large volumes, and at very economical cost, in connection with illuminating operations in this country, having thoroughly demonstrated the practicability of the process, very interesting questions present themselves as to its properties and value as a calorific agent. The enormous waste attendant upon the use of coal and other crude forms of fuel, besides the excessive labor involved in the handling of these heavy materials, to say nothing of their high cost in many localities, give the investigation peculiar importance. I propose to lay before you certain interesting facts in connection with the subject, and if my imperfect presentation thereof serves to stimulate an examination by abler hands, I shall be much gratified.

We are met at the outset by the objection that "it is impossible to get more heat from a given weight of coal than it contains." A truism by which it is meant to assert, that if the heat units of the gaseous product are accurately ascertained and compared with those of the fuel expended to produce them, they will be found to be somewhat less, proving a positive loss in the process of change. This is undeniable, if these tests are made upon a laboratory scale, the coal and its gaseous product being burned under water, and so compared; but it should be remembered that no result in practice, even remotely, approximates to this, not more than one-tenth of the actual heat units of coal being utilized by the ordinary methods.

The real question is, whether by transmuting the heat giving elements, or a large proportion of them, from a solid to a gaseous form we do not gain a condition wherein they can be employed with so much greater economy as to more than compensate the loss involved in their gasification. The Siemens gas furnace is generally admitted to illustrate this, and as that method is supposed to represent the most advanced system, it is proposed to institute a comparison between it and the Lowe Water Gas Process.

The gases delivered by the Siemens Producer are the result of a decomposition of atmospheric air, by contact with incandescent carbon. A number of analyses give the following as an average composition per cent. by volume, viz.:

Of hydrogen	7
" carbonic oxide	17
" " acid	7
" nitrogen	69
	100 cubic ft.

It will be seen that only 24 per cent. of these gases are combustible, and that carbonic acid is present in equal proportions with the hydrogen. This small amount of gas, available for heating purposes, is weighted down with three times its own bulk of non-combustible nitrogen and carbonic acid.

The action of these two last named constituents in calorics has not been generally understood or properly estimated. The nitrogen is not merely diluent, but a divisor, and therefore robs the combustible gases of heat to a very serious degree. An inevitable factor in cumbustion, it is peculiarly undesirable as an initial element.

Carbonic acid is yet worse, being not only "non," but really *anti*-combustible, and its antagonism to flame largely neutralizes an equal amount of the combustible gas with which it is associated. The precise figures to cover these points are not determined, and therefore will be presented in a later communication. Even omitting these important items, we shall find quite enough in the way of surprise for this preliminary paper.

The water gas produced by the Lowe process is of the following composition according to Prof. Wurtz's analysis:

Hydrogen	66
Carbonic oxide	34
	100 cubic ft.

Nitrogen and carbonic acid being substantially eliminated, if any variation from these figures occurs it is one of proportion and not of constituents. For the purpose of this calculation it is hardly necessary to discriminate in the calorific values of hydrogen and carbonic oxide, these differences being unimportant for the moment. The first proposition calculated to conflict with preconceived ideas, is that a given weight of fuel will, in practice, yield at least as large a volume of gas from water as from air. The Siemens process claims, by *estimate*, fifty thousand cubic feet from a tun of clean coal (see Percy's "Fuel"), while the Lowe process has obtained that amount by actual measurement. We have, therefore, only to investigate the calorific values of the two products to determine the question of relative economy. The volume of gas from one ton of clean coal would be in the following proportions:

Process.	H.	CO.	CO^2	N.	
Siemens	3,500	8,500	3,500	34,500	50,000 cubic ft.
Lowe	33,000	17,000	0	0	50,000 " "

In combustion in atmospheric air the comparison would be for the combustible products of one ton of coal, as follows:

Process.	N.		CO_2		O.
	Initial.	In Burning.	Initial.	Total.	Required in Burning.
Siemens	34,500	24,000	3,500	62,000	6,000
Lowe	none.	100,000	none.	100,000	25,000

In other words, the Lowe gas will burn at the same cost 4⅙ times as much oxygen as the Siemens, with an increase in nitrogen of only 61 per cent., or, to state it in another form, 4⅙ times the amount of fuel is required by the latter to obtain an equivalent calorific result, without bringing into the computation the divisory function of the initial nitrogen or the depreciating influence of the initial carbonic acid, which are in no way impaired by Mr. Siemens' admirable regenerative system.

The following table will illustrate this last statement:

Process.	Coal.	Initial.		O.
		Combustible gases.	Non-Combustible.	In Burning.
Siemens,	9,333 lbs.	50,000 feet.	159,333 feet.	25,000 feet.
Lowe,	2,240 lbs.	50,000 "	none.	25,000 "

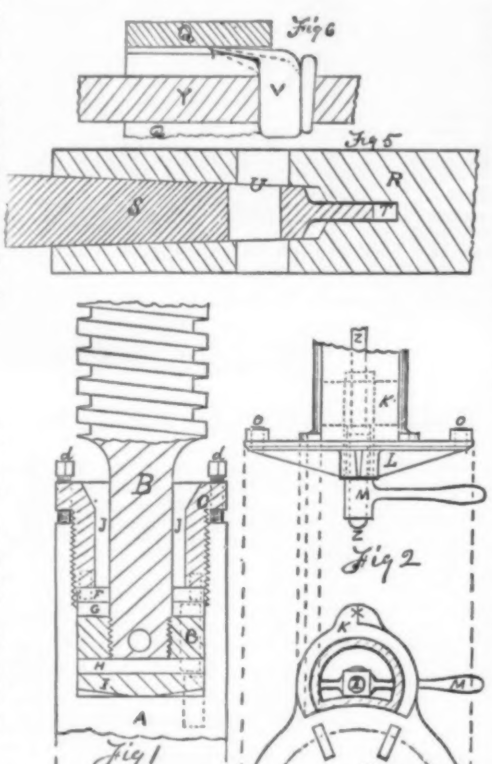
In addition to these important differences in calorific value, there is also a very considerable gain in the matter of intensities, the water-gas showing an increased temperature of about 240° Fahr. The economic relation of this quality to time and labor in metallurgical operations is manifest, and the question also presents itself whether, with a combustible gas which in burning should certainly require less pressure of air blast, the cutting heats which involve so much loss, might be avoided. The possibilities which a discussion of the subject naturally suggests, not alone in industrial enterprises, but in those smaller economies of domestic uses which aggregate such great proportions, we must reserve for future presentation, remaining content with a mere opening of the matter on this occasion.—*Engineering and Mining Journal.*

THE VERTICAL DRILL.

By F. G. WOODWARD.

There is no tool in the outfit of a machinist that is idle so much of the time, probably, as the upright drill; hence the necessity of so constructing it that it shall embrace the widest range of capability as to size of hole it shall make, and size and shape of article it shall operate upon.

To this end the suspension principle suggests itself as the best adapted to the purpose. This gives a clear field upon the floor of the shop for heavy articles to be brought under the drill, and, if it has a table attached to its lower end, it is equally handy for light work. Suspension drills can also be made much lighter, and, of course, cheaper than the standard kind of equal power. The table should be so attached that, by relaxing a single nut, it may be turned back out of the



THE VERTICAL DRILL.

way when drilling articles upon the floor. Fig. 2 shows a good arrangement of table; K the body of the machine; L the table; M the binding nut for holding the table to the body; N a hardened steel ring driven into the center of the table for the reception of boring arbors; this ring should not project above the level of the table; movable rings may be fitted into this for the reception of smaller arbors if necessary; X is a stop to keep the centre pole from passing its exact range with the drill spindle when screwing up the nut M. The upper end of the body of the drill should be firmly bolted to a timber or joist, and four tension rods should extend at an angle from near the lower end of the body of the machine to the joists above; these rods should be perfectly straight and have each a tension link for adjusting the drill to an exact vertical position; there should be an auxiliary speed gear and an automatic feed for use in boring the hubs of pullies, etc. Any of the well known running gear in use on standard machines is of course applicable to those of the suspension principle.

The feed screw should be placed above the spindle, and its lower end should be deeply seated in the top of the spindle so as to form an ample oil cup; as this is an important detail it is clearly given in Fig. 1,—two views, partly in central section. The screw B and the nut E, may be of untempered steel, but the plates F, G, H and I, should be hardened, the plate F being confined to the follower nut C; G and H to the nut E; and I to the spindle A, by dowels, as shown by dotted lines; the plate I, should be convex on its lower face as shown, and have an easy fit in the spindle so as to come to a perfect bearing upon the plate H. As these plates wear away, the binders D, may be turned back and the follower C turned down to take up the slack.

When the feed screw of an upright drill is applied as above explained, the machine may be employed for cutting key seats.

Figs. 3 and 4 represent an extremely simple and handy equilibrium chuck or work holder. It consists of two rings having their bearings at right angles with each other; the one, Fig. 3, may be a quarter of an inch thick and two or three inches wide, and of such diameter as the work may require; the two opposite loops fit loosely upon the studs O in the drill table L, as indicated by dotted lines. At right angles to these loops are two studs P, against which the opposite prongs of the ring, Fig. 4, rest when the chuck is in use. The four binding screws are for holding the work. The chuck is useful for holding gear blanks, wheels, small pullies, etc., which require holes of moderate size, and which can be made with a drill and seamer. It is requisite that the article to be operated upon be, previously, accurately centred, either with a center punch or with a core by the moulder, and that nothing obstruct the free movement of the rings in the direction of the arrows; to facilitate this movement, a small pulley may be placed upon each of the four studs O, P. The article to be operated upon should be placed upon the table with its fairest force down, and should be held firmly by bringing the tool down upon its centre while setting up the binders; then the tool should be eased up a trifle before starting the machine; when the tool begins to cut there will be an equal bearing upon each of the four studs O, P, and of course there will be no tendency of the tool to work from the centre.

It is not good practice to use a set screw in the side of a drill spindle or socket for holding drills, as it has a tendency to wear the socket one sided; there are other methods more efficient and satisfactory, one of these is shown in Fig. 5, central section; R, the drill spindle; S, the shank of the tool. For ordinary drilling and seaming a single mortice T through the spindle is sufficient both for starting out the tools and for keeping them from turning in the socket; but for boring arbors, large seamers and such cutters as need to be held more firmly, a second mortice, U, may be made both through the spindle and the shank of the tool; the mortice through the shank being a little lower than that in the spindle as shown, so as to give an inward draw upon the shank when a key is applied. Boring arbors if used for cutting key seats, should bottom in the spindle, or else they should have a shoulder to bear against the end of the spindle, otherwise they would become so firmly seated in the spindle as not to be easily removed. A key seat cutter should have its advancing face nearly parallel with the bottom of the key seat, as shown in central section Fig. 6; Q the hub of pulley; Y the arbor; V the cutter; if given as much clearance as indicated by the dotted lines, it would be likely to draw and give trouble.

THE LOWE GAS PROCESS.

The "Lowe Water-Gas Process" was first introduced in the working scale at the town of Phœnixville, Pennsylvania, some three years ago. These works have been in operation, without interruption for repairs or other causes, from the date of going into operation to the present time, supplying in summer about 5,000, and in winter 10,000 cubic feet of gas per day. The experience at Phœnixville demonstrated, to the complete satisfaction of those interested, that the product of the Lowe Process was no more liable to stratification and condensation than the product of ordinary coal-gas works—one of the gravest objections that water-gas systems have had to meet. The system was next introduced at Conshohocken, Pennsylvania, some two years ago, where up to the present time, it has been in satisfactory operation, supplying in summer some 6,000 cubic feet, and in winter about 12,000 cubic feet of gas per day. The efficiency of the Conshohocken plant will be best appreciated when it is stated that, from the date of starting the works, one man has made all the gas, collected all the bills, attended to all the service pipes and metres, and has not been employed at the works more than three hours of each day.

Shortly after the completion of the Conschohocken plant, works were erected on the Lowe system at Columbia, Pennsylvania, and up to this time have been producing from 22,000 to 25,000 cubic feet daily.

The Lowe Gas Works at Utica, N. Y., a city of some 30,000 inhabitants, built in the year 1874, were the largest that had up to that time been erected. Their capacity was over 200,000 cubic feet daily. The actual production for a number of months, until the unfortunate destruction of the works by fire, was about 120,000 cubic feet daily, representing a total production from April, 1874, to January, 1875, of 21,000,000 cubic feet. The works in question were erected hurriedly, to meet the terms of a contract, and at the season of the year when the erection of a permanent structure was impossible. In consequence thereof, they were built largely of wood. The inopportune destruction of the Utica plant was the subject of much regret at the time of its occurrence, for the performance of the works had been so remarkably successful as to have attracted the attention of professional gas-engineers throughout the country. The technical papers at the time teemed with glowing accounts of the successful solution of the "water-gas problem," and the leading gas chemist of the country, after a thorough examination of the process and product gave the system his unqualified approval in a report of a most exhaustive character. The Utica works, nevertheless, were sufficiently long in operation to demonstrate the perfect adaptability of the Lowe system for the production of illuminating gas of high quality upon the largest scale, and to secure for it the distinction of being a thoroughly practical solution of the "water-gas problem," which a generation of inventors had been vainly striving to attain. It is affirmed, at the time of this writing, that the works will be promptly rebuilt.

Within the present year the Lowe system has been introduced at Dobson's Mills (Falls of Schuylkill), Stroudsburg, Pennsylvania; Clyde, and Fort Plain, New York, and at Manayunk, a suburb of Philadelphia.

At Kingston, Canada, works are at present in course of erection, and the company under whose efficient management the Lowe process has reached its present successful attitude, has effected contracts for the building of works at the cities of Lancaster and Harrisburg in Pennsylvania, Trenton in New Jersey, and Baltimore in Maryland.

The Lowe Gas Works at Manayunk, with which we are here specially concerned, were built as test works. They were completed during the summer of the present year, and went into operation on the 4th of August.

The plant consists, essentially, of three generators (of

which at present but two are used), and six superheaters, three of which are used for superheating steam and three for fixing the gas. The other portions of the plant, condensers, purifiers, etc., will require no special mention. The generators are 10 feet, 6 inches in height, and have an internal diameter of 40 inches. The superheaters are 15 feet in height, and have an internal diameter of 34 inches. Both generators and superheaters are very solidly constructed of fire-brick, and have double wrought iron walls, with an intervening air space. Generators, superheaters, condensers, scrubbers, and station meter are all contained within a building 27x57 feet. The capacity of the new works is estimated to be 350,000 cubic feet, but up to the present time they have been producing from two of the generators, worked only to one-half of their capacity for production, about 150,000 cubic feet daily, and having an average illuminating power of 19 to 21 candles. (Photometric tests of the gas made in several successive heats, during a recent visit of the writer, indicated an average illuminating power of 20 candles.)

The experienced observer, in examining the works in question, will be struck at once with two facts, namely, the great compactness and simplicity of the plant, and the surprising rapidity with which gas of excellent illuminating power is produced. These points will be best illustrated by the following comparison:

The old works (the usual coal-gas plant) occupied with all their necessary appurtenances, about an acre and a half of ground. The retort house (109 feet long by 33½ feet wide) was furnished with ten benches of threes, and when worked continuously to their full capacity, could produce about 5,000 cubic feet of gas per hour, and a quantity not sufficient to supply the local requirement, and the deficiency was supplied by running into the holder an additional supply from the Market street works.

The new works occupy scarcely one-tenth of the space of the old (the essential portions of the plant, as before remarked, being included in a building 27x57 feet.) They are not run up beyond one-half of their capacity, and are supplying on an average 150,000 cubic feet of 20-candle gas daily, quite enough to meet local requirements, and employ the services of but seven men, three on the night shift, and four during the day. The results obtained, although highly satisfactory, and extremely gratifying to progressive gas engineers, are, however, by no means as complete as possible. The greatest economy in cost of production will naturally be found when the works are running up to full capacity. At Manayunk the two generators and three superheaters are so alternated that while one set is employed in generating and fixing gas, the other pair is being blown up preparatory to a charge. The duration of an operation is about thirty minutes. The average run of each set is from 6,000 to 6,500 cubic feet in the period named, but this volume has frequently been greatly exceeded and single runs on one set of apparatus have given as much as 13,500 cubic feet in thirty-five minutes. The cost of the 20-candle gas delivered into the holder, inclusive of labor, and interest on the investment, is admitted by the managers to be about 35° to 40 per cent. less than that of coal gas of 16-candle power suppllied to the city. This estimate at the present high price of petroleum will certainly be reduced when oil is cheaper. The quantity of oil supplied to the generators is gauged to flow at such a rate that about three gallons of oil shall be supplied, to the 1,000 cubic feet of gas made. This quantity has been found by experience to be about the best proportion, when the heats are right, for making gas of 20-candle power. Up to the present time the Manayunk works have been in operation without the slightest interruption from the date of starting, and have supplied about 10,000,000 cubic feet of gas.—*Polytechnic Review.*

FRENCH PRIZES FOR NEW DISCOVERIES.

The French Society for the Encouragement of the National Industry publishes in its *Bulletin* a valuable list of inventions needed in France, together with the prizes which the society is prepared to award to the successful competitor in each class. Below we give the details concerning the inventions which American inventors may possibly be able to supply. The amounts of the premiums offered are not very large, but it must be remembered that the successful inventors will receive the official endorsement of this great society, and will thus virtually have their productions brought before the French people under the strongest possible recommendations.

The general rules governing the competition are as follows: Descriptive memoirs, models, specimens, etc., designed to make known the names of competitors must be deposited in the office of the secretary of the society, before January 1, of the year designated by the programme for the awarding of the prizes. This regulation is absolute.

Competitors treating several of the questions submitted for competition must consider each separately, sending the separate memoirs, etc., to different commissioners.

Competitors who do not wish to make their devices public property, should patent them in France prior to submitting them for competition. Nevertheless authors who may desire to keep secret their processes, and may decide to present publicly only the results without taking a patent, will be admitted to competition under the condition that they deposit in a sealed packet a detailed description of the processes the exactness of which shall be verified and certified to by a member of the proper committee. Descriptive memoirs, etc., will not be returned to unsuccessful competitors; but the society will allow copies to be made of them and will authorize the return of models and specimens.

The grand medals and prizes of the society, are as follows: 1. The grand medal (gold) is to be awarded in 1877-78-79-80-81 and 82, to inventors (French or foreign) of works which have exercised the greatest influence on the progress of French industry during the six years preceding the date of award. The medal for 1876 was awarded to M. Giffard, inventor of the Giffard injector.

2. Grand prize of the Marquis d'Argenteuil. This amounts to $2,400, and will be given in 1879 to the author of the most useful discovery tending to advance French industry wherever France has not reached superiority over like foreign industry. 3. Grand prize of the society, $2,400. This is decreed in 1882 to the author of the discovery most useful to French industry. There is besides a prize of $800 for improvements in the cotton industry to be awarded in 1877, and another of $100 to be given in 1880 for the most important engineering and architectural improvements.

These are the general prizes, which are hardly open to actual competition. Those which will attract the attention of inventors the world over are the following:

MECHANICAL ARTS.

1. Prize of $400 for a motor of from 25 to 100 horse power, burning at the maximum and during work, 24·1 oz. (avoirdupois) of fuel of good quality per hour and per horse power measured on the shaft of the machine, weighing less than 660 pounds, and costing from $60 to $80 per horse power.

Any generator may be used or any fuel. The machine must be susceptible to general employment and the experiments upon it must be continued over several days or even months, so that all deductions may be rigidly correct. This prize will be decreed in 1881.

2. Prize of $200 for a small motor for domestic use.

Something is here wanted to drive sewing machines, churns, and such like mechanism. There must be a rotary shaft capable of delivering from ·82 to 2·7 foot pounds per second. The machine must of course be easily manageable. The award will be made in 1878.

3. Prize of $400 for progress in the mechanical spinning of flax and hemp.

Flax mechanically spun does not reach the degree of fineness obtainable by hand spinning. The spinning frames are more voluminous, heavier, and hence more costly than those used in making other threads. The intervention of hot water is indispensable, and the power used is much greater than is spinning other material. These facts complicate the industrial operations, limit the products, necessitate considerable expense, render the work unhealthy and explain the slowness of the development of the flax and hemp industries. The above prize will be awarded to whoever will produce, mechanically and continuously, threads of linen of a fineness exceeding 145,454 feet to the pound, or threads of hemp of a fineness exceeding 21,818 feet to the pound. The production of these threads in all numbers must be attained with an economy of at least 15 per cent in power, and with such a diminution in the temperature of the water that if its action remains necessary that the same shall result in no sensible absorption. In order to obtain this prize which will be decreed in 1878 at least $4,000 worth of linen and hemp thread prepared as above described must have been delivered to markets.

4. Prize of $400 for the combing of ordinary cotton and other short filaments prepared hitherto by carding.

The society considers that fabrics prepared from combed cotton offer great advantages over those made from carded cotton. The machine required should not cost more nor be more difficult to manage than the present carding apparatus. To obtain the prize it must have produced at least 22,000 pounds of combed fibers. A complete collection of samples showing the work at various stages must be submitted. The prize will be decreed in 1879.

5. Prize of $400 for a machine for cutting files of all kinds.

Despite the many inventions, the earliest of which was made four centuries ago, for the above purpose, no practical solution of the difficulties presented has ever been reached. This failure is due to delicate and complex conditions which it is necessary fully to realize. If we examine an ordinary 1 foot file, it will be found having from 140,000 to 900,000 teeth according to fineness, or as it has received the bastard or smooth cut. If well executed by hand, the work leaves nothing to desire in point of regular form and spacing of the teeth, and yet the operator has produced the implement with from 30,000 to 50,000 blows of the hammer struck on the same tool under identical conditions. Machines have been devised for imitating this hand work, but the principal cause of failure lies in the lack of elasticity of the apparatus, and the apparent necessity which exists for the exercise of the intelligence of the operator which no machine has obviated. The society think that the investigations which hitherto have been directed to the transmission of motion in the machine should be now directed to the tool used. If a successful apparatus is produced, it is required that it produce files which rival the best made by hand, the mechanism must act without shock, and the cost and management of the machine must have advantages over the expense and utilization of hand labor. Lastly the machine must have worked regularly for at least three months. The prize will be decreed in 1880.

6. Prize of $400 for a method of deadening vibrations of mechanical hammers:

It has been found that the use of drop and steam hammers in cities, is objectionable, owing to the shocks and vibrations which they transmit to walls, etc. In Paris, where workshops are often located in crowded tenements, these concussions are a great nuisance. What is wanted is something to prevent the vibrations being propagated outside the workshops. The prize will be decreed in 1877.

CHEMICAL ARTS.

1. Prize of $400 for the industrial application of oxygenated water.

The object here is to introduce more of the oxidizing processes known to the chemist, into the general industries for bleaching, etc. Oxygenated water was discovered by Thenard in 1818, and although it is a very powerful oxidizing agent its decomposition produces merely oxygen and water, which exercise no deleterious after action as in the case of the chlorides, etc. Oxygenated water is easily prepared, since it is not necessary to have it pure, foreign inert matters not impairing its efficacy. The cheapness of carbonate of baryta and of nitric acid in France, allows of the economical preparation of caustic baryta, which is the basis of oxygenated water. Atmospheric acid suffices to transform the caustic baryta into dioxide of barium, and the latter may be decomposed by carbonic acid. M. Dumas points out that this allows of regenerating the carbonate of baryta and reconstituting the dioxide, and that it furnishes oxygenated water diluted with water, but pure, and finally that the preparation may take place in closed vessels by regular processes and continuously. The question is how can this powerful oxidizing agent be industrially utilized on a large scale. Prize to be awarded in 1879.

2. Prize of $400 for the economic preparation of ozone and for its applications. The society points out that ozone has all the advantages of chlorine without the inconveniences attending the use of the latter. After acting on organic substances it leaves only inert substances, while chlorine yields hydrochloric acid which must be removed, while it frequently is substituted for hydrogen and thus engenders many complications. Some means of producing ozone easily and with economy is needed, and also a plan for keeping it so that it may always be at disposal in large quantities for industrial use. The prize to be awarded in 1881, is offered for the complete solution of the problem, but the society will encourage all serious attempts.

3. Prize of $400 for the fixing of atmospheric nitrogen under form of nitric acid, of ammonia, or of cyanogen.

It is immaterial under which of the above forms the atmospheric nitrogen is fixed, since it is easy to pass from one form into the other. The fixation may now be done in various ways. Thus a mixture of potash and charcoal calcined highly in contact with the air, absorbs nitrogen and produces cyanide of potassium. This process was tried as the basis of fabrication of prussiate of potash. It appeared, however, that the losses resulting from the volatility of the cyanide at the high temperature required caused its abandonment. But other cyanides, less volatile, may be profitably used for the preparation of Prussian blue and industrial cyanides.

The problem is to obtain, industrially, cyanide of potassium, or any other nitrogenous compound under acceptable economic conditions for the fabrication of fertilizers, by taking nitrogen from atmospheric air (to the exclusion of animal matters). The prize will be decreed in 1877.

4. Prize of $400 to the manufacturer who, using pyrites, shall be the first to commence to deliver sulphuric acid free from arsenic.

It is well known that the use of pyrites in the manufacture of sulphuric acid, results in introducing into the latter arsenic in the form of arsenious or arsenic acid. As sulphuric acid is employed in food preparations, the arsenic is a highly dangerous ingredient. Hence the above prize for its complete removal, which will be decreed in 1880.

5. Prize of $200 for the new industrial utilization of any cheap and abundant mineral substance. Chalk, lime, plaster, clay, silex, sulphate of soda, of baryta, granite, fluoride of calcium, phosphate of lime, sea salt, sulphate of iron, iron ores, etc., are all sources of possible new utilizations which might be of great value. The most important utilization found will obtain the prize in 1879.

6. Prize of $200 for the utilization of factory refuse. This relates to new utilizations of slag, salts of manganese from chloride of lime factories, mother liquors from salt works, etc. Any new utilization of material now wasted in industrial operations is wanted. Prize given in 1879.

7. Prize of $200 for a useful application of newly discovered metals.

What can calcium, thallium, magnesium, barium, strontium or any of the new metals be used for? Magnesium, it is known, while burning gives a splendid light. The other metals have each some especial property. What is it and how can it be profitably used? Prize to be given in 1877.

8. Prize of $200 for new applications of non metallic simple bodies.

Silicium, boron, bromine, iodine, selenium, and phosphorus, were formerly rare bodies, but now may be easily obtained and studied. What can they be used for? Prize given in 1877.

9. Prize of $200 for the discovery of a new alloy useful to the arts. Almost all the alloys used industrially have been known for ages. One new metal, aluminum, has yielded a valuable bronze, which will be widely used as soon as the time comes when the abundance of the metal admits of its being cheaply produced. What other new metals can enter into useful alloys? How can such alloys be industrially applied? Are there any new properties of old alloys? Prize given in 1877.

(To be continued.)

THEORY OF SPECTRAL RAYS.

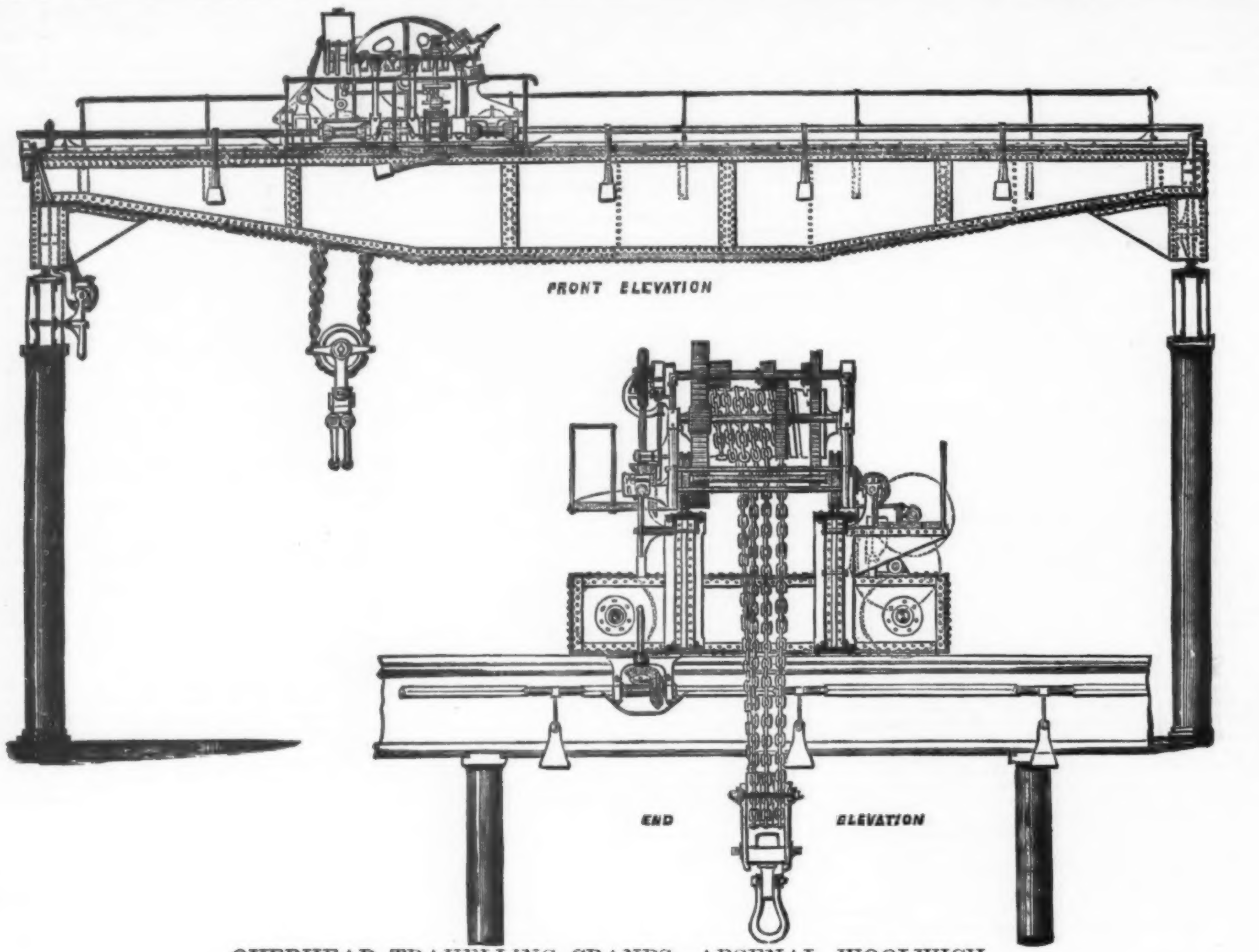
M. G. SALET finds that many chemical elements, especially the non-metallic, have two spectra—one formed of lines, which is due to atoms, and one with bands, which pertain to molecules. Iodine in the state of vapor at the ordinary pressure gives an absorption spectrum composed of channelled bands of the beautiful color peculiar to this element, and which cannot be due to an unknown compound of Iodine. But if an electric spark of high tension is caused to strike through the vapor there is obtained a totally different spectrum, composed of brilliant rays, the arrangement of which stands in no relation with that of the absorption-bands, and which do not coincide with those of any other known element. From analogous reasons M. Salet considers that it must be admitted that bromine, sulphur, &c., have each two distinct spectra. A spectrum with bands is also obtained with nitrogen, however it has been purified. The vapors of the alkaline metals yield also by absorption spectra quite similar to those of the non-metallic elements. The multiplicity of spectra appears, therefore, a general fact. The band-spectra, due to complex molecules, appear at temperatures where certain atomatic groupings may still exist. The line-spectra appear when a very elevated temperature has disaggregated these combinations, and forced the atoms to arrange themselves in a more simple manner. It is to some extent a spectral allotropy.

THE BRIGHTON (ENG.) WATER SUPLPY.

AN official inspection was lately made of a considerable addition to the Brighton Water Works, just completed by Messrs. Eastons and Anderson. Some years ago the Town Council of Brighton took the business of supplying water into their own hands; and new wells being thought to be necessary, the owners of the Stamford Estate allowed the Corporation to purchase, at a very moderate price, a suitable piece of down land, at Goldstone Bottom, in a suitable situation favorable for sinking into the soft chalk. Two shafts having been completed, of a depth of 150 and 180 feet respectively, these were connected by a tunnel, and other tunnels were driven in such directions as to form a subterranean quadrilateral, with the result that rivers of considerable size were opened. The tunnels are about 6 feet wide and six feet high at the crown of the arch, and their total length is more than half a mile. On reaching the bottom of either of the shafts, the visitor finds himself standing close to a large flow of pellucid water, which wells out of a hole in the chalk, and forms a stream, by the banks of which he may walk until he reaches the vicinity of one of the pumps. The power to do this depends, however, upon the pump being in full work at the time; for, as soon as its action is suspended, the water not only speedily fills up the tunnels, but also rises to a considerable height in the shafts. Lately, in order to finish the work, it has been necessary to keep the water as low as possible; and for this purpose, the quantity pumped has amounted to no less than 7,000,000 gallons a day. The present requirements are fully met by about half this quantity; so that the Town Council has the command of twice as much water as is actually required.

THE CRANSTON AIR COMPRESSOR.

We annex illustrations of a double air compressor, constructed on the plans of Mr. J. G. Cranston, of New-Castle-on-Tyne. The compressor has one steam cylinder, with one double-acting air cylinder on each side of it, the three piston rods being all coupled direct to the flywheel shaft without any intermediate gearing being employed. The advantage of this arrangement is that the working strains are equally divided on each side of the steam engine centre crank, which arrangement greatly reduces the wear and tear, and should an increased air pressure be required, double the pressure can be obtained with one cylinder, by simply lifting the suction valves of the other air cylinder out of gear; while the steam cylinder crank being set almost at right angles to the cranks



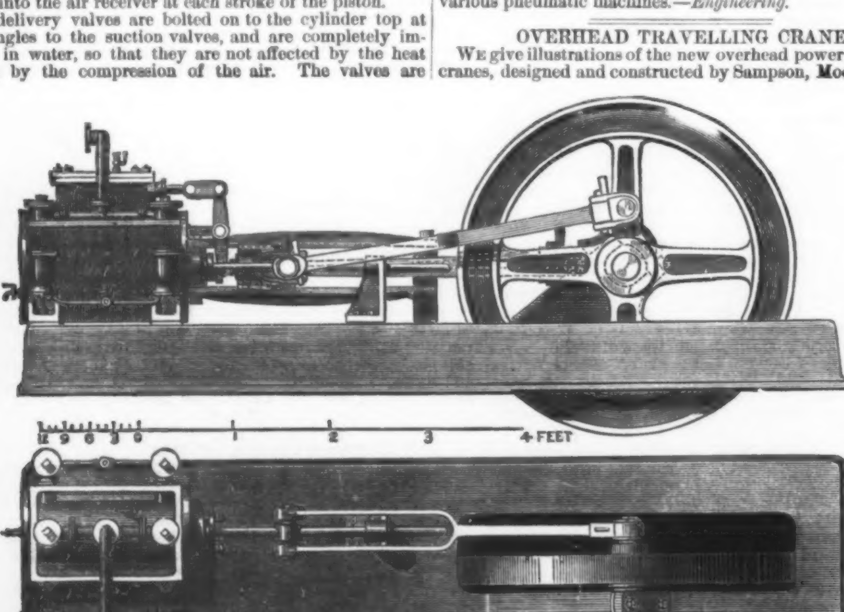
OVERHEAD TRAVELLING CRANES—ARSENAL, WOOLWICH.

of the air cylinders, the most effective power of the steam cylinder is obtained at the point of the greatest compression in the air cylinders.

Each cylinder has two gun-metal suction and delivery valves bolted closely thereon, the casing of the suction valves and the valves themselves being overhanging and fixed to the side of the cylinder. They are provided with water cups close to the inlet, so that a bead of water constantly surrounds the valves, keeping them cool, and providing at the same time a certain quantity of water to the air cylinder, which acts as a lubricant and packer between the piston and valve spaces as it is alternately drawn in by the action of the piston, so that almost the whole of the compressed air is delivered into the air receiver at each stroke of the piston.

The delivery valves are bolted on to the cylinder top at right angles to the suction valves, and are completely immersed in water, so that they are not affected by the heat evolved by the compression of the air. The valves are nearly of the shape known as the mushroom valve, and are made with spherical faces, as shown. Their arrangement will be best understood by referring to the section, Fig. 2.

In some cases these compressors are driven by water power, being geared from a turbine or other hydraulic motor. They can be run at a very high speed when required, the valves acting with the greatest certainty at a pressure exceeding seven atmospheres. The whole of the machinery is firmly mounted on a strong cast-iron bed plate, so that little or no foundation is required. When required for mountainous districts, where the carriage on road is difficult, the bed plate is reduced in weight, in order to facilitate the carriage. These compressors are extensively used for the driving of various pneumatic machines.—*Engineering.*



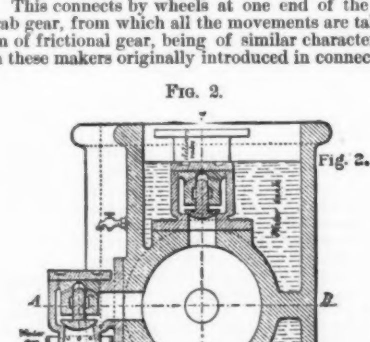
THE CRANSTON AIR COMPRESSOR.

OVERHEAD TRAVELLING CRANE.

WE give illustrations of the new overhead power travelling cranes, designed and constructed by Sampson, Moore & Co., North Foundry, Liverpool, for the Gun Factory of the Royal Arsenal, Woolwich, forming part of the requisite powerful plant used in that establishment in the manufacture of the heavy guns. The nominal ordinary working load of these cranes is 60 tons, but they were each tested with a weight of 100 tons, which they lifted at the rate of 12 in. per minute; and traversed transversely and longitudinally with ease and facility, all these movements being under the ready control of one man only, either for single or simultaneous action. One of the cranes in the machine shop was recently employed in the removal of the 81-ton gun from the boring mill, after receiving its increased bore, and performed the duty in the most satisfactory manner, the gun being lifted and lowered into its required position with the most delicate nicety. The crane in the turnery is 34 ft., and those in the machine shop are 54 ft. span, with the girders and end carriages of wrought iron, constructed on the box principle. Upon these is mounted the powerful crab, which has gear for three speeds of lift connecting to the barrels upon which the chain winds in one coil, and thence passes to the massive lower block.

The power is communicated to the cranes by a shaft driven by the shop gearing, and attached to the longitudinal girders upon which they traverse, and supported by tumbling bearings. This connects by wheels at one end of the crane to the crab gear, from which all the movements are taken, by a system of frictional gear, being of similar character to that which these makers originally introduced in connection with

FIG. 2.



THE CRANSTON AIR COMPRESSOR.

the power travellers they designed and supplied to the London and North-Western Railway Company's erecting shops at Crewe Works, in the year 1860. The power in the latter named cranes, and in most of the large number constructed by the same makers since that date, was communicated by a rope, which has been found to answer exceedingly well, especially for shops of great length. In this instance, however, it was considered desirable to introduce a shaft for that purpose, which has been most successfully accomplished, that in the turnery driving one crane being about 250 ft., and in the machine shop driving two cranes 130 ft. long, each in one unbroken length without any couplings.—*The Engineer.*

BRAKELL'S BLOWER AND EXHAUSTER.

THE engravings illustrate a new and ingenious form of blowing and exhausting apparatus, by C. Brakell, of London. It is a compact machine and has few working parts, so that it can be supplied at a very reasonable price. It is equally

FIG. 1

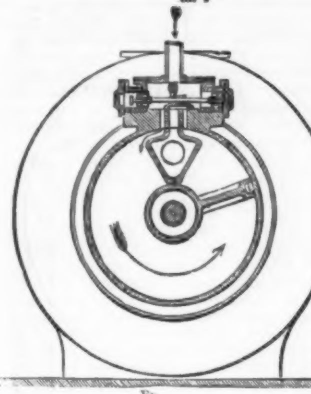


FIG. 3

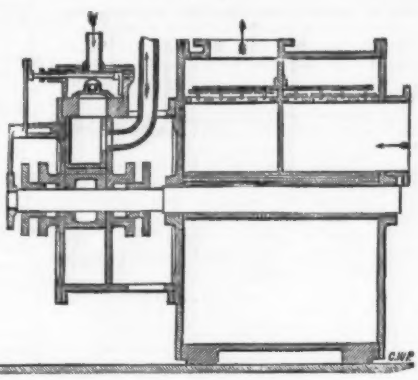


FIG. 4

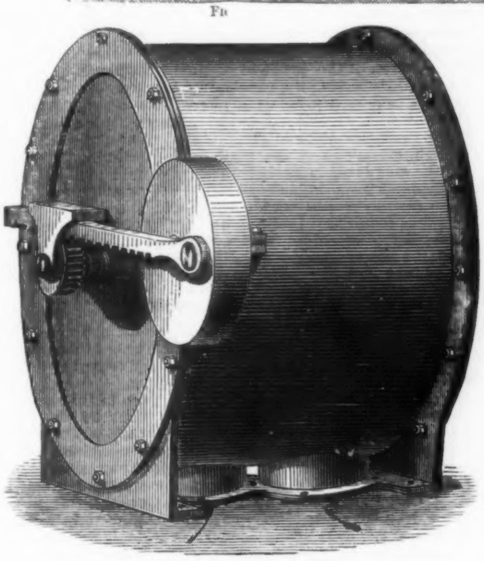
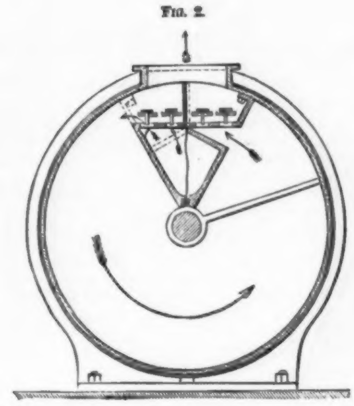


FIG. 2



BRAKELL'S BLOWER AND EXHAUSTER.

applicable for producing blast of a few inches water column, or 100 lb. or more per square inch. As an exhauster it can produce any depression, from a few inches of water column to within the limits of a vacuum, or say 12 lb. per square inch. Having no fly-wheel there is no heavy mass of dead weight to be suddenly set in quick motion and retarded or slowed, as in the ordinary type of blowing engines. The piston can start off at a quick speed, having little resistance at first, and gradually runs slower as the resistance increases, without the slightest wrench or jar. One of these blowers having a cylinder 36 in. diameter, for blast of 13 lb. pressure per square inch, has been run at 180 strokes per minute without being bolted down or secured in any way. This machine only occupied a space of 5 ft. long and 3 ft. broad, and when running at its regular speed of eighty single strokes per minute, was equal in capacity to a blowing engine of the ordinary type 26 ft. in length and 3 ft. broad.

The illustrations, Figs. 1 to 3, show a steam blower for compressing air up to 1 lb. per square inch, or 28 in. water column, and its dimensions are: air cylinder 42 in. diameter and 32 in. long or deep. The air piston is, therefore, 32 in. by 18 in., or an area of 576 square inches, and the steam piston is 5 in. by 9 in., or an area of 45 square inches. The construction will be readily understood by the illustrations. Fig. 1 shows the steam engine in section, Fig. 2 shows the blower in section, Fig. 3 shows a longitudinal section of the combined engine and blower.

The machine consists of a steam cylinder and an air cylinder, having one shaft through the centre, supported by bearings in the cylinder covers. On the shaft are fitted a steam piston and an air piston, which have a reciprocating circular motion from one face of the fixed abutment to the other.

The alternate admission of steam to each side of the fixed abutment in the steam cylinder is regulated by an ordinary slide valve. The spindle of the valve forms a small piston at each end, which work in cylinders formed in the valve-chest. Steam is admitted to each piston alternately by a small finger valve, to which motion is given by a lever actuated by a cam on the main shaft of the machine.

This valve arrangement, which is of the simplest kind, enables the blower to be run at any required speed from two or three strokes per minute upwards, and is unfailing in its action. There is also a lever (not shown) by which the valve can be worked by hand. It may also be mentioned that the valve pistons have steam buffers which obviate the shock, hitherto the weak point in the steam-moved valves of direct-acting pumps.

The valves of the air cylinder in the blower illustrated are formed of thin circular steel plates, which lift, both for suction and discharge, from the flat surface of the abutment.

Fig. 4 shows the Brakell blower arranged to be driven by belt from any other steam engine, or by hand—and consists of a spur pinion fitted on the blower spindle gearing with a rack, to which the necessary reciprocating motion is communicated from the circular motion of the driving pulley.—*The Engineer.*

STEAM MORTAR MIXER.

At the last show of the Royal Agricultural Society, Messrs. Barrows and Stewart exhibited a very neat combination of mortar mill and engine, which deserves the notice of contractors. It is illustrated in the accompanying engraving. This engine and boiler are of sufficient power to drive the 6ft. mill when grinding lime, brick ends, slag, iron ore, &c. The engine has a cylinder, 8in. diameter by 10in. stroke, governors, fly-wheel, turned so as to take a strap for driving a saw bench or band saw if required, the pinion driving the mortar mill being thrown out of gear. The boiler is made of best plates, and fitted with one 8in. cross tube. The mill has a revolving pan 6ft. diameter, fitted with false bottom plates, easily replaced when worn; the pan is supported in its travel by turned friction rollers, and the bottom of the pan is also turned. The rollers are 2ft. 10in. diameter by 11in. wide on the face. They weigh 15 cwt. each. There is also an arrangement for the footstep being taken out and replaced without lifting the pan or the rollers. The whole is on a strong hollow cast iron frame, and mounted on travelling wheels and powerful wrought iron carriage work. The workmanship is good, and the parts are well put together.—*The Engineer.*

STEAM MORTAR MIXER.

WHY FINE GOLD FLOATS.

Although most miners recognize the fact that gold in fine particles will float or remain for some time suspended in water, few know why this is so, as it seems contrary to the principles of gravitation. A series of experiments made a long time since by one competent to judge, proved, first, that fine particles of gold would remain afloat in water of common temperature for over 24 hours; and, second, that when the temperature of the water was raised to, or near to, the boiling point, the suspended particles of gold would subside. Reflecting on these points, the experimentor was reminded of the well known property possessed by platinum of condensing gases upon its surface, and it seemed no far fetched hypothesis to assume that gold and, probably, most other metals, possessed the same property, though in a less degree. Upon this supposition, the fact that particles of gold did not sink in water in accordance with their specific gravity was readily explained, because the buoyancy of the film of air or other gas adhering to them would more or less counteract their weight, and as the surface of bodies relatively increases as their bulk decreases, it was plain that the smaller the particle of gold the more apt it must be to be kept afloat by a film of gas upon the surface. It also becomes obvious that when the water is heated to a certain degree, the particles of gold suspended therein must subside, because the film of gas sustaining them would be expanded and removed.

On this peculiar characteristic of metals to condense gases, Overman may be cited as an authority (Metallurgy, p. 282). "As not only the specific gravity, but the size of grain and its affinity for water and other minerals, has a decided influence on its tendency to subside, it is evident that the operation of separating minerals is truly one which requires more than common intelligence to perform it well. Iron is by far specifically heavier than quartz, still fine iron filings will float in water, while fine sand sinks directly. Carbon has not the weight of clay, yet carbon sinks sooner in water than clay, but not so in air. Gold is by far heavier than silex, but we may observe, by means of a microscope, a multitude of fine particles of gold suspended in water, while we cannot detect the slightest particle of silicious matter, however fine it may be. The latter will subside more quickly than visible particles of heavy gold. All the metals appear to have a tendency to float on water when in fine particles, some more than others. This is caused by a particle of gas, either air or water gas, adhering to the particle of metal, which causes it to be light and float or become suspended. Precious metals appear to possess more of this quality than others. Sulphurets of metals, oxides, salts, and, in fact, all compound matter, do not manifest it. The size of a particle and its form have also some influence in causing heavy matter to subside in water; a large grain will, in all instances, sink faster than a small one."

Unless we accept the explanation that a great deal of gold escapes with the water, despite its high specific gravity, it will be difficult to account for the loss in working with a continuous current from the stamps. We ourselves had some extremely fine gold in a bottle of water, not long since, and, as a matter of curiosity, shook it up and set it on the desk to see how long it would take before settling. On the second morning minute particles could still be seen suspended in the water, although the water had been perfectly quiet in the meantime.—*Mining and Scientific Press.*

INCREASE OF THE WATER SUPPLY FOR NEW YORK CITY.

By SAMUEL McELROY, Civil Engineer.

The state of the Croton supply during the past season is one calculated to attract the attention of hydraulic engineers, and invoke prompt and efficient remedies. The demand of the lower city, increased by the premature enlargement of the feeding mains, has drawn the usual supply of the upper city, when the city reservoirs were constantly depleted in head and storage by the restricted capacity of the aqueduct, and by the failure in supply of the reservoirs in the Croton Valley. For a long time the city reservoirs have been deprived of a full head, and since last winter have been much lower than usual.

The drainage area of the Croton Valley is taken at 338 square miles. Its formation is such, that it has a powerful storm flow, and a limited summer, or dry weather flow. It is estimated, therefore, that although the minimum flow is about 30 millions, where the city demand is 100 millions, the valley is capable of supplying 300 millions per day, if the surplus is properly stored.

The present storage capacity in this valley consists of the Croton Lake, 500 millions; Boyd's Corners Reservoir, 3,000 millions; and several natural lakes available for 2,000 millions, or a total of 5,500 millions. The capacity of the city reservoirs is 1,170 millions, being 6,670 in all, which is equivalent to a supply of $96\frac{7}{10}$ millions per day, for 100 days of greatest demand, in the low run of the river, and much less than this if the city reservoirs cannot be filled, as has been the case, owing to an inadequate aqueduct and an inadequate reserve supply.

The need of New York for an increased aqueduct capacity and an increased valley reserve has been fully recognized, and it is estimated that $20,000,000 expenditure will be required to effect this improvement. In this case a new aqueduct is contemplated and reservoir construction in the upper valley.

Having had occasion, for many years, to study the progress of this supply, in my opinion New York has within its reach a system of increase, much more simple than that contemplated, which is open to several objections, among which are these:

First, that the surplus flow of the Croton Valley can never be successfully impounded, so as to realize the extravagant estimates of the engineers identified with the present storage reservoirs, which claim a yearly average, as possible, up to 280 or 270 millions per day, and this, partly, because the right and uses of the valley itself must be respected, and partly because the location of these storage reservoirs, is, of necessity, restricted to the upper feeding valleys, while the greatest area of the catchment basin is below their sites, and the supply, therefore, beyond reach.

Second, because the location of the present aqueduct is such, that no independent, parallel structure can be built, without an excessive outlay for lands and structures for over 40 miles.

The plan which I have to suggest, then, looks toward the immediate increase of the capacity for storage of the surplus storm-flow of the aqueduct and the Croton Valley, together with a simple and economical enlargement of the aqueduct itself. Obviously the best place to secure the storm-flow of the Croton is at the Croton dam, and at points as near it as practicable, instead of abandoning the entire valley for 18 to 34 miles above it, at elevations more than 400 feet higher. It is also obvious that if the walls of the present aqueduct are properly strengthened, they may be carried up to a greater height, so as to double its capacity, without any expenditure for new lands, culverts, and various other costly structures.

Between the Croton Lake and the Harlem River, the aqueduct crosses a number of brooks with deep valleys, which are now carried beneath it by expensive culverts. It also crosses very large streams, like Mill River, 13 miles below the dam, and the Sawmill River at Yonkers. Among these are:

Creek.	Depth of Valley.	Miles below Dam.
India	58′	6
Several near Sing Sing	20′ to 32′	
Sing Sing Kill	82′	
Hale's	49	9½
Rider's	34	10½
Several Brooks	20′ to 30′	11½
Mill River	87′	13
Requa's	25	15
Jewell's	62′	17½
Wilsey's	49′	18½
Storm's	40′	19
Cook's	42′	
Dykman's	35′	23
Sawmill River		
Tibbitt's	40′	26
Acker's	37′	34

From these valleys a proper selection could be made to secure two results; an independent storage supply, by closing the culverts, and a convenient place for supplemental aqueduct storage. These can be arranged, by proper structures, to take such portions of the surplus flow of the Croton, as it may be able to supply; advantage may also be taken of such a construction and supply, to facilitate the enlargement in height of the present aqueduct walls, section by section, commencing at the Harlem River.

In direct connection with this plan, the dam of the Croton Lake should be raised, so as to control, by the present incline of the aqueduct inlet, about 8 feet additional aqueduct depth. The increased level of the lake flow line can be suffered to expand into these lateral valleys where the damages are light, while more valuable lands and sites can be protected by levees.

In this way will be secured the increased storage capacity of the lake, the increased capacity to deliver surplus flow into the lower supplemental reservoirs along the line, and the increased hydraulic head of the aqueduct proper, for the control and supply of the city reservoirs, and for the effectual delivery of all the supply available from the Croton Valley, from time to time secured.

In connection with these supplemental valleys which will largely increase the future and effective drainage area of the aqueduct, and in view of their depth below the aqueduct, the use of auxiliary pumps may readily be had, and especially during its reconstruction, so as to secure their benefits fully.

Examination would probably show that the supplemental reservoirs proposed, need not of necessity use the aqueduct as a dam, but might, in some instances, be built in the lateral valleys and connected by a branch aqueduct so as to supersede auxiliary power, but it is for the interest of the city to secure the most ample enlargement of supply and storage practicable, and within the least distance from the city.

Brooklyn, Dec. 9th, 1876.

PHOTOGRAPHS ON WOOD FOR ENGRAVING.

By EDWARD POCOCK.

The boxwood block is one of the most difficult surfaces on which to photograph, on account of its uneven grain; and in large blocks, where there are a number of small pieces bolted together, the difficulty increases, as no two pieces are alike in grain. There are two things demanded by the wood engraver—one being that the photograph shall not "shell" under the graver; the other that it is impossible to pencil on the block as in a drawing. Many attempts have been made in this direction, but with little, if any, success.

The simplest method, perhaps, of photographing on wood is the following: Take a negative of any subject and fix it against one of the studio windows; place a piece of ground glass behind it, and outside the window reflect light through it at an angle of 45° with a piece of white cardboard, or, better, a piece of looking glass. Cut out a hole in brown paper the size of the picture, so as to cut off all light but that coming through the negative. Now focus the copying camera sharply. Prepare a plate in the ordinary way, taking care to use thin collodion that will take a good picture. The time of exposure can only be arrived at by practice. With Ross's 8¼x6½ triplet, medium stop, sixty seconds in good light are sufficient. Develope with:

Iron	15 grains.
Acetic acid	1 drachm.
Water	1 ounce.
Alcohol	*quant. suff.*

Fix in hypo.; wash well, and tone with the acetate and gold bath, which must be rather weak and old. When the picture is toned it should show the same color on both sides of the glass. Wash well; now put the plate into a bath of water to which a few drops of hydrochloric acid have been added; scratch round the image with a sharp knife (rather larger than the wood block) and the film will now leave the glass and float on the water. Then take the wood block, rub on some flake white mixed with a little of Thomas's dry albumen and a little water and work it well over the wood, after which rub off all that will come away with the palm of the hand. When dry, plunge the wood under the film, and, having got it into the right place, gently raise the two out of the water. Place the block between blotting-paper and well press. After this wash the block in alcohol to absorb the water; trim the edges of the film, and, when dry, the collodion will be found firmly adhering to the wood, and will not cut up under the tool. The objection to this process is that it cannot be pencilled on; but it will answer well where the original photograph is quite perfect.

The other process is one that gives a good surface for the pencil. Take a negative, which must be reversed. The best way to do this is to expose the back of the plate in the dark side; when the picture is developed it will be found to be the same way as the original. The negative required should be sharp, and without any deposit in the shadows. It is better to work with a strong developer that has ripened to about the color of old collodion. To prepare the block, take flake white and fine brick dust, or bath brick, rub it well over the block, and then rub it off with the palm of the hand. When dry, coat the wood with—

White india-rubber	1 grain.
Chloroform	1 ounce.

Take—

Alcohol	1 ounce.
Ether	1 "
Pyroxyline	7 grains.

This gives two ounces of plain collodion. Now make up in three bottles—

1.	Nitrate of silver	120 grains.
	Water	120 minims.
2.	Chloride of ammonia	64 grains.
	Alcohol	1 ounce.
3.	Tartaric or citric acid	64 grains.
	Alcohol	1 ounce.

To two ounces of plain collodion add one drachm of No. 1, to which has been previously added one drachm of alcohol; shake well; then add one drachm of No. 2, shaking well all the time; and lastly, half a-drachm of No. 3, letting it stand one hour, and filter through cotton wool. It is now fit for use. Then take the wood block and coat it in the same way as a plate, and dry gently before the fire. The block is now ready to be put into a printing frame of the ordinary kind, with stout plate glass in front. Bring the block into position on the negative. Now take slips of wood and glue them on the negative (this will enable the block to be taken up and examined); bring down the bars of the frame and expose in the shade. These pictures must not be overprinted, as they lose little or nothing in the toning and fixing.

When the block comes from the printing-frame it should show a beautiful picture, blood red. It must now be put into the toning and fixing bath—in one bath—without washing. The one given on page 198 of *The British Journal Photographic Almanac* for 1876, with a slight modification, will answer. It should be as follows:

1.	Chloride of gold	3 grains.
	Chalk	15 "
	Water	5 ounces
2.	Sulphocyanide of ammonium	25 grains.
	Carbonate of soda	2½ "
	Hyposulphite of soda	240 "
	Water	5 ounces.

Toning is best done in a flat dish, laying the block face downwards till toned; it is then well washed under the tap for about three minutes, taking care to wet the back all over, or water stains will appear. On this surface a pencil will take on washes of India ink. A considerable number of the Landseer sketches which are appearing in the *Art Journal* have been done by this process.—*The British Journal of Photography.*

A SOLAR DISTILLERY.

By M. A. MOUCHOT.

The author presents to the Academy a small "solar alembic," easy to set up and to remove. The mirror is 50 c. m. in diameter; the boiler contains 1 litre of wine, which is brought to a boil by a half an hour's exposure to the sun. The vapor of alcohol enters a tube placed in the centre of the boiler, traverses the foot of the mirror, and descends into the worm, where it condenses. The foot of the mirror is a gas tap fitted with a groove and a set screw, which permit the boiler to be always turned to the sun. If the boiler is filled with water, and if a receptacle full of leaves or odoriferous flowers is interposed between it and the worm, all the essences procurable by distillation may be obtained.

HERMANN'S NEW SIZING METHOD.

It is unquestionably of the greatest importance to the weaver to have his warps so prepared that they may stand all mechanical shocks, during the weaving process, which may present themselves through frictional or tension causes; consequently, the solution of this problem has been attended with more or less satisfactory results. We say more or less, because these results have not come up to the hopes entertained with regard to the expected durability and evenness f the thread, but have involved loss of time and costliness in this preparatory stage. Hence the great labor that has been spent in the attempts to invent such a sizing process as would dispense with the great waste of time incurred in the manual after sizing in hand looms, as well as with the very costly mechanical substitutes, the profitable use of which is restricted to large manufacturing concerns.

The usual sizing of the yarn in skeins, or by the pound, is, as the practical man knows well, insufficient, without resorting to after-sizing, for the production of durable and pliant warps. The various methods at present introduced, which recommend a sizing mass of greater consistency, have the common defect that the yarns on drying sticks together, so causing the warp to roll up or even break in the winding process. Again, the means adopted to reduce the sticking together of the yarn also remove a certain portion of the size, so that what is gained on the one side is lost at the other.

A few years back a machine was introduced which worked the sized yarn in skeins by brushing it, and in such a manner that in spite of the greater consistency of the size used the yarn threads should be laid loose and smooth after drying. The durability of a yarn prepared in this manner was found quite equal to that found in other yarns sized by hand or machine labor; so much so that, with this fact established, the solution of the problem seemed to be reached, and the question respecting the preparation of yarns, skein or pound fashion, appeared to be set at rest. The subsequent reeling alone of such yarns brought the defects of this machine sizing process clearly to light, for the yarn of the skeins, although loosened and smoothed by the brushing operation, yet the many breakages which occurred and had to be pierced up made so many knots as to render the weaving very defective; for this reason such yarns could not be used for the purposes required. Ignoring the defects of construction of these sizing machines, which rendered a simple and rapid feed of such machinery quite impossible, this method was abandoned and put aside, as being not sufficiently worked out for practical purposes.

It is well known that size does not act alike on all kinds of cotton, but differs according to twist, count, and color of the cotton; thus one kind may take the size easier than another, and, in such a case, it is far easier to pay regard to this peculiarity when sizing the yarn in the skein, than when it is on the loom, etc. The sizing of the yarn in the skein has another advantage, inasmuch as if the yarn be dyed, even with non-genuine dyes, these coloring stuffs will not smear or run into each other, as often occurs when sizing in the warp, and consequently, the samples when sized in the skeins appear much more lively and cleaner than otherwise. A. M. Carl Herrmann, who has devoted a number of years to this particular study, announces that he has succeeded in determining the most advantageous size receipts for the various counts of colored yarns, and that by his method and the use of his sizing material, a uniform, pliant, and polished warp yarn may be obtained, the strength of which is increased by his sizing process. The sizing material which he uses is said to be a splendid substitute for the finishing process of such goods, in which a soft pliable touch is required with a velvet glossy appearance, and this same size may be advantageously used as a cheaper substitute in the paper manufacture.

Yarns treated with this sizing material, not merely show themselves to be well adapted to the reeling process, etc., but it dispenses entirely with after-sizing, both on hand and power looms, and thus enables more work to be turned out in a given time, besides making the work much cleaner. With regard to cost of production it is certainly cheap, averaging from 4 to 6 markpfennig (= ½d. to ¾d.) per English lb. weight, according to the wages paid and yarn counts required. The new skein sizing machines required for this process take up with all their accessories ten square metres standing room, and the power required to drive one of these machines does not exceed the power required to drive an ordinary power-loom. With an attendance of six girls or non-skilled hands, this machine can prepare or size 50 lbs. of yarn per hour; if a smaller quantity requires only to be sized, the number of tenters may be reduced in proportion.

To obtain an almost strictly uniform sized yarn without devoting much care, the yarn may be drained or dyed, after sizing, preferably by one of Fisca's hydro-extractors, as the use of wringing rollers, etc., used in other constructions act detrimentally. In conclusion, the process just described is said to be equally well adapted to the sizing of linen yarns, in which case a sort of stretching apparatus is added to the machine.—*Das Deutsche Wollengewerbe.*

CHINESE SILK PRODUCTION.

A CORRESPONDENT of the *Augsburger Allgemeine Zeitung*, writes from Rome the following particulars on the Chinese silk yield, basing his remarks on the report of the Italian Consul at Shanghai. The silk yield, he says, in the northern districts of China, has turned out this year far inferior to an average crop. At the beginning it was thought that the yield would come up to within 72,000 bales of the preceding crop, but the frosts did great havoc in those districts which began first, and almost completely destroyed the eggs in the Hayen district. As the expectations on the late crop were also totally deceived, it is saying much in estimating the export trade from this year's harvest at 52,000 bales. Meanwhile the latest European news has caused such a rise in prices that a climax was reached which had not been attained before for many years. It is, therefore, probable that the Chinese, in order to make the most of the rise in prices, will bring all the available silk of former years into the markets, and thus the total exports from Shanghai may still come up to 60 000 bales.

ECONOMIC PRODUCTION OF WHITE LEAD.

THE improved means of producing white lead by the wet way proposed by Mr. R. Palmer, of Ovington Square, Brompton, consists essentially in the treatment of acetate, or any other soluble salt of lead, with carbonate of soda in. He takes one equivalent of acetate of lead, and grinds it up with an equivalent of crystallized carbonate of soda. When this combination has attained a certain consistency, say that of cream, he allows it stand until complete decomposition takes place, then adding water to wash out the corresponding salt of soda (which may be crystallized or utilized in the most advantageous manner), and finally drying the white lead in the usual way.

SALICYLIC ACID IN THE MILK TRADE.

By DRS. L. MANETTI and G. MUSO.

THE authors recommend the use of salicylic acid for the preservation of cream in small farms where butter is made only a few times in the week, and for the preservation of butter where there is no convenience for storing it in places at a temperature not higher than 6° to 8° C., as well as to keep it from rancidity when forwarded during the summer season to distant markets.

MANUFACTURE OF SULPHURIC ACID.

IN the production of sulphuric acid Mr. C. E. Armengaud, sen., of Paris, takes either certain anhydrous sulphates (such, for example, as those of iron, zinc, and alumina), which at a high temperature split up into the residual base, and a mixture of sulphurous acid and oxygen, or he takes certain anhydrous bisulphates (such, for example, as those of potash and soda) which at a high temperature split up into neutral sulphates and a mixture of sulphurous acid and oxygen. Either of these sulphates or bisulphates he strongly heats in a retort or in a muffle furnace, constructed of brickwork or other fire-resisting material, so as to effect their decomposition. He then passes the resulting volatile products and gases over substances (such, for example, as spongy platinum or the oxides of chromium or of iron or copper), which at a moderate temperature—at about a dull red heat or somewhat below that temperature—possess the property of causing the sulphurous acid and oxygen to combine, so as to form anhydrous sulphuric acid. This he condenses either alone in a suitable apparatus, or he causes it to be absorbed by ordinary sulphuric acid, so as to form Nordhausen or fuming oil of vitriol. Of the anhydrous sulphates which may be employed for this purpose he prefers to use anhydrous bisulphate of peroxide of iron, and of the anhydrous bisulphates he prefers to use anhydrous bisulphate of soda.

WHAT BECOMES OF SALICYLIC ACID AFTER IT IS ABSORBED?

Two answers have been given to this question. It is believed by some authorities that the acid enters into combination with the alkaline bases of the blood as soon as it mingles with that fluid, and that it is subsequently eliminated as a salicylate. Feser and Friedberger, on the other hand, assert that it unites in the first instance with the albuminates of the plasma, and is only converted into a salicylate when those albuminates are broken up—that is, just before it is excreted by the kidneys. The former of these views is adopted by Binz, but with one important modification. He argues that the carbonic acid generated in the tissues is able to decompose the salicylate and to liberate minute quantities of salicylic acid in immediate proximity to the germinal centres. The question has been investigated afresh by Fleischer (*Centralblatt für die Med. Wiss.*, September 2, 1876). He finds that free salicylic acid is never present in the blood, and that it forms a permanent compound with a base immediately after its absorption. A portion of it displaces carbonic acid from the carbonates; another portion acts upon the neutral sodic phosphate of the plasma. Salicylic acid, like hippuric and benzoic acid, is able to withdraw sodium from the neutral phosphate, sodic salicylate and acid sodium phosphate being formed. This fact is all the more curious as phosphoric acid readily expels salicylic acid from its combinations.—*Academy.*

THEORY OF LUMINOUS FLAMES.

By DR. KARL HEUMANN.

THE author considers the circumstances that a gas-flame does not actually touch the edge of the burner, nor a candle-flame the summit of the wick; and that a flame never comes in close contact with a cold body is due to the fact that heat is conducted away by the solid body. The flame-gases are cooled for a certain distance below their ignition-point, and the flame is consequently extinguished within this region. The distance between a gas-flame and the burner is considerably increased if the inflammable gas or vapor streams out under a high pressure, or is mixed with a large amount of some non-inflammable gas. This phenomenon is due not merely to the cooling action of the gaseous stream and of the external air, but to the fact that the speed of the issuing gas stream close to the burner is greater than the speed of the propagation of ignition. When other influences are not essential, the flame begins in that section of the issuing gas-current where its speed equals the speed of the propagation of ignition. Hence this speed of propagation for different gases and vapors may be experimentally ascertained. In case of solids and liquids of a combustible nature the same speed may also be readily found by experiment, and the results may be regarded as relative numerical expressions of the dangerous character of the combustibles in question.—*Annalen der Chemie.*

SUSPENSION OF CLAY IN WATER.

W. DURHAM, F.R.S.E., discovers the fact that alkalies and their carbonates in small quantity prevent the coagulation and precipitation of clay suspended in water. I consider this as an interesting discovery, and one that may enable us to explain the persistent suspension of clay in what we take as *pure* water. For instance, the purest water we would take for experiments of this sort contains ammonia, either free or as carbonates. Why not, therefore, suppose that this ammonia forms a compound with the silica of the suspended clay, resembling soap in type of constitution, silica of course corresponding with the fatty portion of such substances. As is well known, all soaps deport themselves like clay with regard to the phenomena under consideration.

I would like to know the deportment of *pure* water with *pure* hydrous silicate of alumina in regard to the question under consideration. Clay seems *permanently* suspended in strong ammonia.—WILLIAM SKEY, *Chemical News.*

A NEW REAGENT FOR GLUCOSE.

By A. SOLDIANI.

416 grms. of bicarbonate of potassa, 15 grms. of basic carbonate of copper (dry), 1400 grms. of distilled water, are placed to heat on the sand-bath in a porcelain capsule for about six hours, the liquid being kept always at the same level by adding water to make up for what is lost by evaporation, and stirring. The heat is withdrawn when the evolution of carbonic acid ceases; it is left to settle, and filtered, and concentrated to 800 c.c.

TRITYLENE.

A READY means of preparing this gas in large quantities is proposed by A. Claus and Kerstein (*Ber. Deut. Chem. Gesell. Berlin*, ix. 695). They mix with concentrated syrupy glycerine, having a boiling-point of 196°-200° C., as much zinc in powder as it can moisten, and then heat the mixture, when a larger amount of gas is given off; 100 grammes of glycerine yield from thirty to forty-five litres of gas, consisting of about equal volumes of hydrogen and propylene. No other gases, apparently, are found. When treated with bromine, about one half of the gaseous mixture is absorbed, forming a yellow, oily liquid which boils at 142° C. and possesses the formula $C_3H_6Br_2$.

USING sulphuric acid and snow, which produced a temperature of 37° C., L. Pfaundler reasoned that if he could reduce the temperature of the material he used he would be able to produce a still lower temperature. Accordingly he packed a tall cylinder with snow, and, pouring in the acid, soon obtained the temperature as above. A series of layers is formed, which increase in temperature downwards; but the excess of acid in contact with the upper layer having now reached a temperature of 37°, a temperature considerably under this point will be obtained as it percolates downwards and comes in contact with very cold snow. Temperatures of from 50° to 60° were thus obtained. In a paper by J. Tollinger (*Wien. Aus.* 1875, 172) will also be found two useful tables giving the result of his experiments in connection with freezing mixtures of nitrate of ammonia with water and with snow.

FROTHING OF COLORS.

THE printer is at times troubled with a froth forming on gum or albumen colors during the working which may increase to an extent which, besides filling and overflowing the color-box, renders it impossible to print well; for the engraving, instead of being filled with good substantial color, is occupied by a mixture of color and air bubbles which of course gives a bad impression and a light shade. Froth in color consists of an assemblage of air bubbles, and is formed by the motion of the color causing it to mix with air; but why some colors allow this mixed-up air to pass away and escape easily without inconvenience to the printer, and why others retain it in the state of bubbles with such remarkable tenacity, is a question concerning which very little or nothing at all is known. Gummy or gelatinous fluids are all more or less capable of retaining air in bubbles, but soapy and albuminous solutions are conspicuous for the permanency of the froth formed in them by air, probably owing to a greater elasticity or tenacity of the thickening matter, and it is common to attribute the excessive frothing of gum colors to the presence in them of impurities of an albuminous kind. Ordinary saline solutions, such as alum, nitre, or common salt, have no power to retain air bubbles when shaken up with air. The only salts in common use which possess this property are, curiously enough, the acetates so much employed as mordants, and there is no explanation of the fact. As a general rule, froth is destroyed by the addition of any fluid which does not mix with the frothing medium, and the usual remedy for a frothy color is to add a certain proportion of oil or other fatty matter, turpentine, petroleum, or naphtha, and with pigment albumen colors ammonia is sometimes employed as a preventive. Frothy color subsides in great measure upon standing for a few hours, and leaves color which can be again employed. The color which works fairly with one printer may froth excessively with another. Upon examination this will be found owing to some difference in the lapping of the furnisher, or the speed with which it is travelling, or some other trifling arrangement in the working which causes the color to be beaten up in contact with the air and so form the froth.—*Textile Colorist.*

DYEING, PRINTING, AND BLEACHING.

By M. MICHEL DE VINANT.

Royal Blue, or French Blue.—The present method of dyeing a Prussian blue upon wool was discovered in 1835 or 1836 by Messrs. Merle & Malartique, of Bordeaux. The Prussiate steam blue for printing was discovered in 1838 or 1839 by M. Etienne Petit, of Rouen, who disposed of it to M. Meissonier, of Paris. M. Vinant claims for himself and M. Dajon the first application of white and orange discharge upon Prussian blue, and holds himself out as an example of an inexperienced young inventor who let the profits of this discovery enrich strangers.

For a piece of woollen cloth weighing 70 lbs., take 10 lbs. of yellow prussiate, which dissolve in a little water, 4 lbs. sal ammoniac also dissolved, and 3½ lbs. of crystals of tin also in solution. In the quantity of water necessary for this weight of cloth mix 15 lbs. of sulphuric acid, then add respectively the sal ammoniac, the tin, and the prussiate. Enter the cloth and heat up to 86 degs. F. for the first hour, to 104 degs. for the second hour, to 131 degs. for the third hour, to 158 degs. for the fourth hour, to 203 degs. for the fifth hour, and to a gentle boil for the sixth hour; if the blue is not fully developed, 3 lbs. additional of sulphuric acid may be added. Next day give it four or five ends, and wash.

For a lighter shade take, say for 72 lbs. of wool, 6 lbs. prussiate, 2½ lbs. sal ammoniac, 2½ lbs. crystals of tin, and 6 lbs. of sulphuric acid; these quantities may be still further reduced for light blues. For very dark blue the following quantities and materials are given: 40 lbs. of wool, 6 lbs. prussiate, 6 lbs. sal ammoniac, 6 lbs. sulphuric acid, 12 lbs. alum, and 6 ozs. crystals of tin; the time of dyeing required is five hours.

Another dark blue is obtained by first treating the wool with stannate of soda, and then dyeing in prussiate, acid, and some tin salt. A common blue is obtained upon 40 lbs. of wool with 2½ lbs. of prussiate, 2½ lbs. sulphuric acid, and 5 lbs. alum, heated up for three and a half hours, and then 2 ozs. of crystals of tin added, and the dyeing continued for one and a half hours longer. Several other receipts only slightly differing from these might be given, but we add only one more, for light sky blue. For 50 lbs. wool take 20 gallons of water, 4 lbs. alum, 4 lbs. cream of tartar, 1 lb. yellow prussiate, enter cold, and heat gradually to boiling in two hours, then add 1 lb. sulphuric acid and 3 lbs. oxymuriate.

Scarlet Dye on Wool.—This color is either from lac or cochineal; the tin mordants are most important. The following are given by Vinant:—

Scarlet Mordant No. 1.—Three quarter pounds common salt, 2 gallons water, dissolve and add 15 lbs. nitric acid, and then gradually 1½ lb. of granulated tin or rolled tin.

Scarlet Mordant No. 2.—Thirty pounds muriatic acid, 2 gallons warm water, 15 lbs. nitric acid, 9 lbs. of tin dissolved with care

The solution of tin for preparing the lac lake for dyeing is made by dissolving 11½ lbs. tin in 71 lbs. of hydrochloric acid. For 50 lbs. of the lac lake in powder take 25 lbs. of this tin solution and 5 gallons of warm water, and leave three or four days in contact before using. To dye 20 lbs. wool scarlet with lac lake, boil three quarters of an hour with 2 lbs. tartar, and 2 lbs. of the scarlet mordant No. 2; lift and add 1 lb. tartar, 2 lbs. scarlet mordant No. 2, and 7½ lbs. of the prepared lac lake; boil one hour to one hour and a quarter; if the color is then short of brightness some more mordant may be added, if it is deficient in depth some more of the prepared lac lake may be added. Turmeric is employed where quite fast colors are not necessary.

Cochineal Scarlet on Wool.—For 10 lbs. of wool take 1 lb. tartar, ¼ lb. turmeric, 1½ lb. of cochineal in powder, and 2 lbs. of the scarlet mordant No. 2. Boil for an hour or an hour and a quarter, until the full depth of color has been obtained.

Dark Scarlet-Pink on Wool.—Thirty pounds wool, 2 lbs. white tartar, 4 lbs. scarlet mordant No. 2, 2½ lbs. powdered cochineal. Boil as usual.

Light Crimson on Wool.—Thirty pounds wool, 2½ lbs. white tartar, 4 lbs. scarlet mordant, 3 lbs. ammoniacal cochineal, 1 lb. cochineal. Dye as usual.

Turkey Red Color on Wool.—Sixty pounds wool, 6 lbs. to 7 lbs. tartar, 12 lbs. scarlet mordant No. 2, 12 lbs. cochineal in powder; boil for one to one and a half hour, then lift and add 10 lbs. of ammoniacal cochineal, and work for another hour. Recently the ammoniacal cochineal has been replaced by magenta or fuchsine; the color is brighter, but not so fast.

A similar shade can be obtained with lac dye, brightened up with magenta to the desired shade.

Greens on wool are obtained from fustic and extract of indigo, the mordant being alum and tartar, and sometimes sulphate of alumina and tartar; for olive greens archil is added. Greens, in which the yellow part is from picric acid, are dyed with ½ lb. picric acid, 1½ lb. sulphate of soda, and 2 lbs. sulphate of alumina for 10 lbs. wool, and afterwards the necessary quantity of sulphate of indigo.

For fancy shades upon wool the three primary colors, red, yellow, and blue, are mixed in the required proportions, or the wool is brought to the desired shade by superposing one color upon another. The red part is from cochineal, the yellow from fustic, and the blue from sulphate of indigo; with sulphate of alumina and sulphate of soda as the mordanting substances, the shades obtainable are infinite.

DYEING RECIPES.

Yellow Cannelle.—For 100 lbs. bleached cotton. 10 lbs. catechu, 4 lbs. blue vitriol, ½ lb. bichromate. Pass first through the catechu, and wring; then pass through the bichromate, and wash. Repeat the passes, and wash. Finish with 10 lbs. quercitron bark.

Carmelite Olive.—For 100 lbs. bleached cotton. 15 lbs. catechu, 4 lbs. blue vitriol, 1 lb. bichromate. Work same as for yellow cannelle, and finish with 15 lbs. quercitron and one tumbler of pyrolignite of iron.

Tête de Nègre.—For 100 lbs. bleached cotton. 5 lbs. catechu, 2 lbs. alum, 1 lb. blue vitriol, 2 lbs. bichromate. Work as in yellow cannelle. Finish with 40 lbs. red sanders and 1 tumbler of pyrolignite of iron for each 25 lbs. cotton.

Dark Cannelle.—For 100 lbs. bleached cotton. 15 lbs. catechu, 6 lbs. blue vitriol, 1 lb. bichromate. Work as in yellow cannelle, and finish in a boiling bath of 4 lbs. sal soda.

Gold Yellow on Linen (11 lbs.).—Steep for three hours in a boiling beck of 17½ ozs. tannin, and dye in a fresh cold beck with about 3½ ozs. aniline orange, otherwise known as phosphine.

Chrome Orange on Linen (11 lbs.).—Boil up 3½ lbs. sugar of lead in water, with an equal weight of litharge, till the sediment is white. Let settle, and steep the yarn in the clear hot liquid for an hour; take out and take through a cold beck made up of 17½ ozs. lime. Rinse slightly, and work in a cold beck of 17½ ozs. chromate of potash, and the same weight of sulphuric acid, for a quarter of an hour. Redden in a boiling beck with 8¾ ozs. lime, working for three minutes, and rinsing. If a redder shade is required, top in a fresh cold water, with ⅛ oz. magenta.

Rose on Linen (11 lbs.).—Work in a boiling hot beck of 7 ozs. tannin and 3½ ozs. curd soap; add to the water the solution of 3½ ozs. tin crystals, and dye with ⅛ to ¾ oz. saffranine at 110° Fahr.

Claret on Cotton Yarns (11 lbs.).—Make up a beck with 17½ ozs. prepared catechu, and work the prepared yarn in it for one hour. Wring, and steep for half an hour in a hot beck of 6½ ozs. chromate of potash; take through cold water, and work for thirty minutes in a beck of 3½ lbs. sumac at 190° Fahr. Then dye in a cold beck with 1¾ oz. magenta; take out, add to the beck 8¾ ozs. alum and the decoction of 2½ lbs. logwood. Enter again, work in the cold beck; lift, and add, according to shade, from ¼ to 1¾ oz. chromate of potash; re-enter, and work. The color is now complete.

Fast Black on Woollen Yarn (11 lbs.).—Boil for one hour with 4½ ozs. chromate of potash, and the same weight of prepared tartar, finely ground; rinse immediately, and let cool in the liquor, and dye with 6½ lbs. logwood, adding a little fustic, according to shade, and 7 ozs. logwood. Boil for three quarters of an hour. After dyeing, drain, and take the yarns four times through the prepared beck; rinse, and then take three times through an old soda beck. Rinse when the dyeing is complete.

Billiard Green on Cloth (110 lbs.).—Dissolve in a water 16 lbs. 6 ozs. alum, boil in it 29 lbs. fustic, and add 5 lbs. 7 ozs. extract of indigo.

THE color most in favor at the present time is *caroubier*, which seems to combine the red-cardinal and yellow-brown. It is easily obtained on wool in a bath of fuchsine, with the addition of a very small quantity of aniline maroon, or by a mixture of *orchil* with *red wood*, and a little *fustic* added, it is easy to produce this shade.

Eosine is now being largely substituted for cochineal in the dyeing of wool. A beautiful bright scarlet may be obtained by using the following: To 10 lbs. of wool, 3 ozs. of eosine and 8 ozs. of alum.—*Le Moniteur de la Teinture.*

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. McCord.

Second Series.—No. I.

Whoever has mastered the principles and faithfully practised the exercises presented in the preceding series of lessons, should now be desirous and competent to put his knowledge of mechanical drawing to the test of practical application in its legitimate sphere, that is, in the actual drawing of machinery.

But at the risk of repetition we must warn him that, no matter how thorough his study may have been, he has yet much to learn before he can make use of his acquirements to the best advantage. It is one thing to know what to draw, and another thing to know how to draw. It is not sufficient that when we understand the details of a machine, we shall be able to make accurate representations of it in any position which may be assigned.

The object of working drawings is to show the workman what to make and how to make it; and the draughtsman must not only know this himself, but must convey his knowledge by means of his drawings in the clearest and most direct manner; his plans must be not only correct, but the ones best adapted to explain the machine and its parts. His judgment must be trained in the selection of the views which will do this with the least expenditure of labor, and in the proper arrangement of them, so that the relations of the different parts shall be most readily ascertained. This constitutes a very important part of the qualifications of an efficient practical draughtsman, and, unfortunately, it is one which is too frequently neglected.

By far too many think that if they can represent with rigid accuracy the appearance of a piece of mechanism in three views, and do so, no more should be expected, and they are inclined to resent the criticism that those three views which they have made with care and diligence are, perhaps, obscure; one of them, it may be, superfluous, and that on the whole more information might have been given in a clearer manner with less drawing. But it is very often so, notwithstanding; and we intend, if possible, that those who trust to our guidance shall not be subjected to the mortification of having such suggestions made in regard to their work.

Another thing, a really efficient draughtsman should be able to select the parts of a given piece of mechanism which should be drawn and "put in hand" first, which next, and so on in succession, in order that the whole may be completed in the shortest time, if the work be wanted in a hurry; managing matters so that the pattern makers shall not be crowded with work while the blacksmiths are idle and the finishers waiting for something to do, and using his discretionary power in such a way that all parts may be finished as nearly as may be at the time when they are required to be fitted up in place. It will be readily seen that this latter qualification can be attained in perfection only by long experience in actual work in the drawing office of a machine shop. The former, however, is not wholly dependent upon such practice, although it would unquestionably be of the greatest value. But it is impossible to give any set rules by which to determine either what views would be the best in a given case, or the best arrangement of those which may be decided on. There is much scope for the exercise of native common sense and good judgment, which vary greatly in different individuals, and a great deal of assistance may be derived by studying the results of the experience of others. The impossibility above mentioned, of deducing any rules generally applicable, renders it necessary to give the results of our experience in the form of examples of working drawings. These will at first be, naturally, of simple details, and increase gradually in complexity, and we shall accompany them with explanations of the process of drawing them, with reasons for selecting the views that are given and for arranging them as they may be arranged, and also, when it can properly be done, with hints in regard to errors commonly made in drawing the same. This, in relation to the working drawings alluded to—as we have previously stated, it is not to be understood at all that our instructions in the theory of drawing are concluded—exercises of a nature analogous to those which have preceded are yet to come, which, however, will be given in a form distinct from the practical illustrations, except in cases where a problem may present itself in the latter, which is of sufficient importance to be made a subject of abstract study by itself; this, we may add, will frequently occur.

As a preliminary, we must first consider the construction and use of the scale. Heretofore little has been said about this instrument, because in the previous exercises it was of no consequence whether the objects represented were drawn of any specified dimensions or not; accuracy was of course essential, but the measurements might be made with the compasses, the dividers, or with a slip of paper. This, however, is no longer to be so; in drawing details of machinery, we are to make not only accurate measurements, but measurements of specific magnitudes; it is not enough to draw a cylinder correctly, but it must be a cylinder of a definite diameter and a certain length. Through the whole range of the work, we have to deal not only with proportions but with absolute dimensions, and in these no mistakes must be made.

A draughtsman may be lacking in neatness and in finish; he may be slow; even his acquaintance with projections may be defective, but if he be perfectly reliable in respect to his figures, that reliability will hide a multitude of sins. A great responsibility rests upon him, for the workman knows nothing of the plan but what he sees in the drawing given him, which it is his duty to follow implicitly. Mistakes in dimensions are too costly to be tolerated, and the draughtsman who makes many will be apt to lose his employers, who will part with him less in sorrow than in anger.

He who wishes to make good working drawings should, as the first step, provide himself with a good scale, and for the benefit of those who may desire information in regard to this instrument, we will illustrate and describe it.

The draughtsman's scale, then, consists essentially of a strip of wood, metal or ivory, on the edges of which are marked certain divisions. As to the material, we may confine our attention at present to scales made of wood, which are shown in Figs. 1 and 2.

Those of ivory are very expensive, and though pleasant to handle, are not reliable in regard to freedom from shrinking and cracking.

For very minute and extremely accurate work, metallic scales are no doubt the best, but for all the ordinary uses of the mechanical draughtsman, a scale of thoroughly seasoned boxwood is preferable to any other. In length it should be not less than eighteen inches; a professional draughtsman in active practice will find one of two feet more convenient, but no advantage is gained by having it longer.

The reason why it should not be less than a foot and a half long, is that in ordinary work there are so many measurements of more than twelve inches to be set off, that much time would be lost by using a shorter one.

There are two forms of the scale in common use, the flat and the triangular; some prefer one, some the other, and we illustrate both, leaving the choice to the judgment and taste of the reader.

The flat scale is shown in Fig. 1; the transverse section may be of either of the forms, *A* or *B*, the latter being in our opinion the better one, for two reasons. One is, that the sharper edges of the former are more liable to injury; the other, that divisions can be made only on the two sloping faces, *c*, *d*, while in the second form there are four such faces, *e*, *f*, *g*, *h*, which may be utilized, as the angle at the edge is not so sharp, thus giving a greater number of scales on the same instrument; this is an item of some consequence as affecting the expense, wood suitable for the purpose being difficult to procure.

The triangular scale is shown in Fig. 2; its form is that of a triangular prism, lightened by a semicylindrical groove plowed in each side from end to end; we have thus six faces which may be divided instead of four. Another advantage possessed by this scale is, that if it be straight, the lower side lies naturally flat on the board, thus bringing the divisions on the adjacent faces down to the paper, which facilitates the marking off of the distances. But if it warps, this advantage is is lost; true, a flat one may warp also, but it is less likely to do so in the direction of the breadth than in that of the thickness, and the latter is of less consequence, as a slight pressure will bring it into contact with the paper by springing the scale.

Drawings for constructive purposes are preferably made of the actual size of the objects represented, when they are not too large. It may be stated here as a guide in regard to this, that a "double elephant" sheet, 27 by 40 inches, is as large as any drawing should be made, under ordinary circumstances; exceptional cases may arise, in which it may be necessary to go beyond these dimensions, but usually, by reducing the scale, we may keep within these limits.

For the purpose then of making "full size" drawings, one edge of our scale is divided into inches, which again are subdivided into halves, quarters, eighths and sixteenths, precisely as on the ordinary folding rules used by the mechanic.

This is as it should be, for the simple reason that this system of subdivision is the one in common use throughout the country. It is not the place here to discuss the merits, if there are any, of the metric system, or the advantages or disadvantages of the decimal system of subdivision. It is enough to know that neither are in general use; when they are adopted it will be time to change our scales, but it is clear that the system adopted in the shop must be used in the drawing office.

Now, in regard to the lines marking the subdivisions, it will be noted that they are of different lengths, those for the inches being longer than those for the halves, these again longer than those for the quarters, and so on. This makes it much easier to read the scale, as the phrase is, which any one will appreciate who attempts to count, by the eye alone, the pickets of a fence, the teeth of a comb, or the slats of a window blind.

When a great number of equal and parallel lines are thus placed near each other, the eye, having nothing by which to distinguish one from the other, soon becomes confused, so that it is impossible to count with any certainty more than a very few from the end of the row, which the reader may verify by the aid of Fig. 3.

The regular alternation of lines of varying length relieves this difficulty to a very great extent; the addition of longitudinal lines, by which some of the shorter ones are limited, as in Fig. 1, is not absolutely essential, but as a matter of taste the appearance of the scale, in our opinion, is thereby improved, and they do unquestionably still further facilitate the reading. And we beg our readers to understand, that the most minute items which have a bearing on the time occupied in executing work, are worth attending to. We are well aware that there are a great many impatient souls who are anxious to get at the general features of a subject, to whom such minutiæ are apt to seem tedious; but the minutes which are wasted in trying to draw with a scale which necessitates the counting of more or less subdivisions at each measurement, which might be avoided by using an instrument like that shown in Fig. 1, are so valuable that we do not intend to be responsible for their loss.

If the object be so large that a full size drawing would be inconvenient, we avoid the inconvenience by making the drawing smaller, each dimension being reduced in the same proportion, the result being the same as though we had made a full size drawing of a precisely similar but smaller object.

It is for the purpose of facilitating such reduction that the other scales on the instrument are used. We have seen beginners, with just such an implement in their hands, yet making their reduced drawings with the full size scale. Supposing, for instance, that the object was to be drawn one fourth of its actual size, they would divide each dimension by four, and measure off the quotient, with a proud consciousness that their work was correct, because figures cannot lie. There may be some others of that stamp, whom we have not had the pleasure of meeting, to whom a little explanation may be useful. It is very easy to divide by four, no doubt; but it is a monotonous way of spending time, and when the scale maker has been kind enough to do it all for us beforehand, it is a wasteful way as well. And this he has done, in the manner following: If we divide one foot by four, our quotient will be three inches; if we subdivide this space into twelve equal parts, each one of them will be one fourth of an inch; if we still further subdivide these spaces into halves, quarters, eighths, each of these lesser subdivisions will be one fourth of the half, quarter or eighth of an actual inch. Therefore, if we call our large space of three inches a foot, the twelve greater divisions will be inches on this scale, and so on for the subdivisions. In reducing dimensions to one fourth, then, we use this scale; instead of dividing by four and setting off the result by the full size scale, we trust to the scale maker for the division, and set off the actual dimension without any arithmetical process.

This is called the scale of three inches to one foot, and is usually designated on the instrument by a large 3, as shown in Fig. 1 at the left. Only one foot on the scale is subdivided, and it is usual to number only every third inch, thus, 0, 3, 6, 9, 12, as the intermediate ones can be readily counted. It is needless to say that the same system of making the transverse marks for the subdivisions of different lengths, above mentioned in describing the full size scale, is of paramount importance here, as well as in the others, which are still smaller.

Now, we may divide by eight instead of by four. That is to say, we may consider a distance measuring actually one

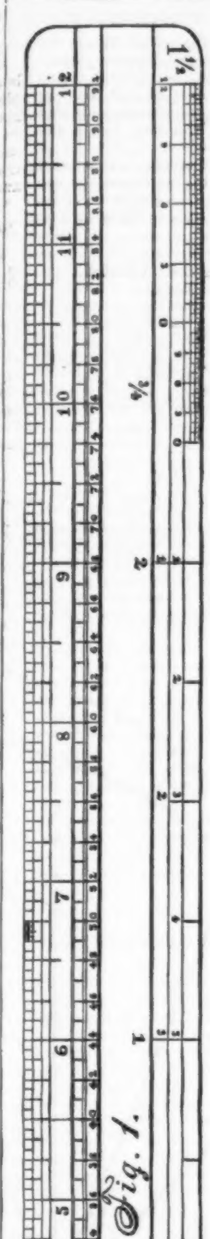
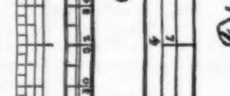


Fig. 1.



A B

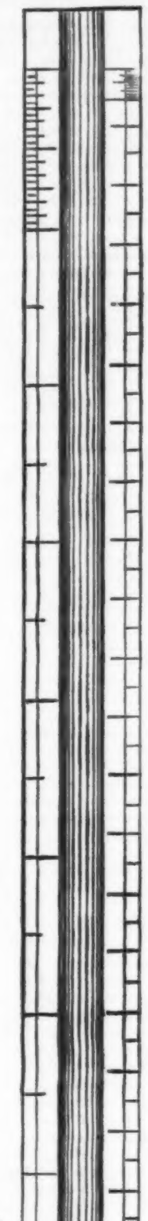


Fig. 2.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES—No. 1.

inch and a half, as representing a foot, divide it into twelve parts, call each of them an inch, and subdivide these again as before into halves and quarters and so on. This is called the scale of one inch and a half to the foot, or briefly the "inch and a half scale,"—and in like manner we call the other the "three inch scale,"—and it is designated by the figures 1½, as shown.

It will be noted that these two scales are on the same edge, which need cause no confusion, if the numbering is properly done, since there is no inconvenience in having the feet on the larger bisected. And, indeed, space may be still farther economised by putting three scales on one edge, which we have done in Fig. 1, a "three quarter" scale, that is, one in which three fourths of an inch represents a foot, being introduced in addition to the two already described. This, however, might by some be considered as making the instrument look rather crowded, and it is not usual to place any more than the three inch and the inch and a half scale on one edge. These are the ones most frequently used, and it may be as well to omit the third one in this case.

Other scales, however, being less frequently used, this objection would be of less moment, if indeed it be of any in any case. Supposing it to be not objectionable, we have thus, as shown in Fig. 1, on one side of the flat instrument the following scales:

Full size, 3 inch, 1½ inch, ¾ inch, ⅜ inch.

And on the other side we may have these:

1 inch, ½ inch, ¼ inch, ⅛ inch, $\frac{3}{16}$ inch, $\frac{3}{32}$ inch.

These, it may be remarked, are the ones most in demand; there are instruments on which we find 4 inch and 2 inch scales, but there is a strong practical objection to their use, which will be subsequently explained, and the reader is advised not to select such, if he can procure one in which some of those above mentioned are substituted for them.

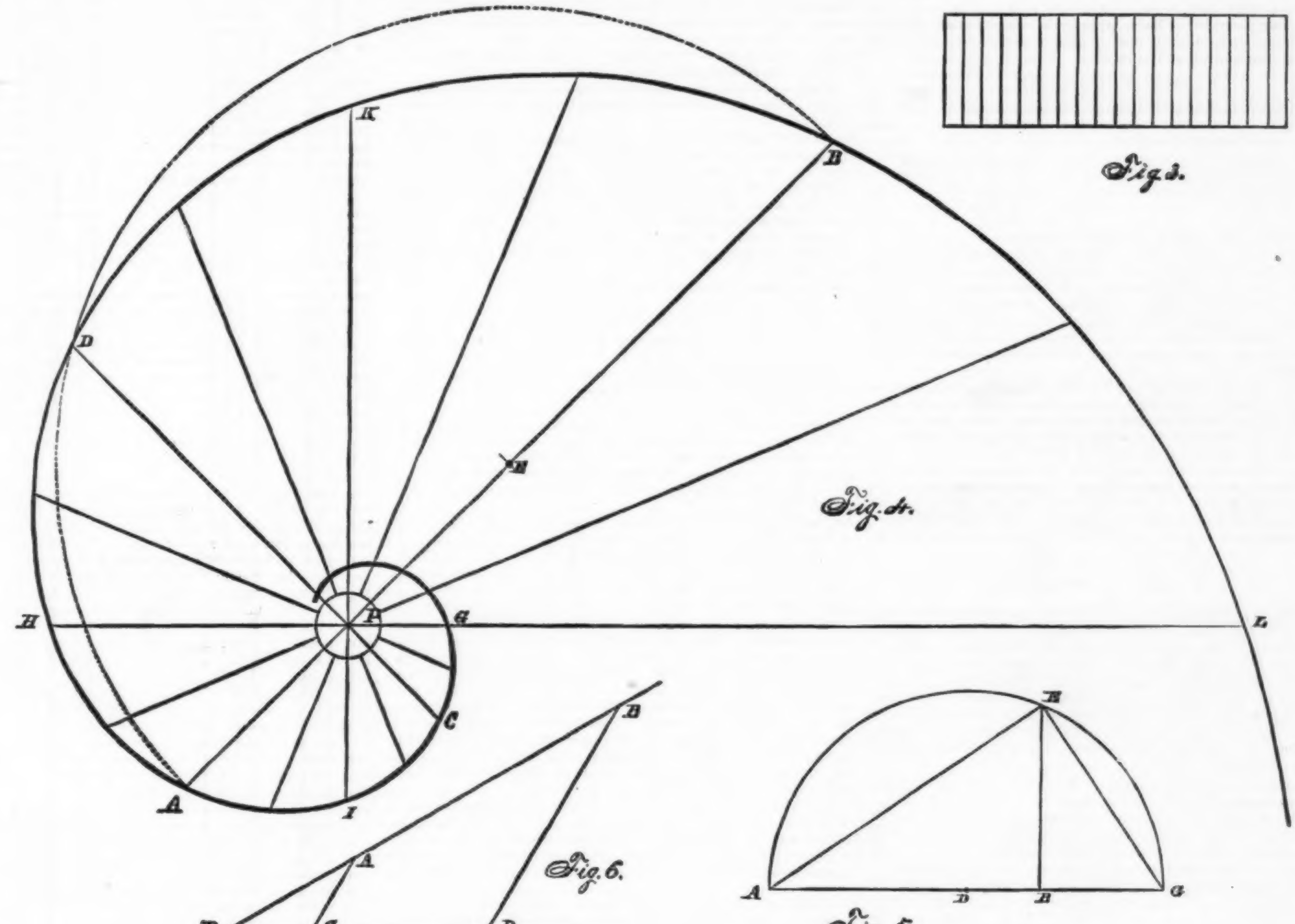


Fig. 3.

Fig. 4.

Fig. 6.

Fig. 5.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES—No. 1.

On the triangular instruments, we have never seen more than two scales on an edge. But those above enumerated may be arranged on the six faces, thus:

Full size		1 inch.	½ inch.	¾ inch.	⅜ inch.
3 inch.	1½ inch.	¼ inch.	⅛ inch.	$\frac{3}{16}$ inch.	$\frac{3}{32}$ inch.

The scale having been selected and approved, should be used with care. It is, if a first class instrument, rather costly,—in fact, it cannot be otherwise, from the amount and delicacy of the work upon it—and every precaution should be used to keep it as good as new. The first and most important one is, to form the habit of setting off distances from it with a pencil or a pricking point. If the pencil be properly sharpened, that is, to a keen edge, rounded so as to resemble the point of a drawing-pen blade, as shown in the first lesson of the preceding series, we prefer it for all except the most minute work.

The scale should be applied to the paper so as to bring the divided edge into contact with it, and the proper points marked off, not by pressing the point of the pencil into the surface, but by drawing a short dash perpendicularly to the edge of the scale, making a fine line with very slight pressure.

If a pricking point be used, there is nothing better than a fine sewing needle, which may be held either in a clamping holder, like the needle-point of the compasses, which may be had at the instrument dealer's, or merely stuck into a little handle of hard wood.

With this the division is marked, by making the finest possible puncture in the upper surface only of the paper. It ought to be nearly impossible to find this spot, and when this mode is adopted it is well to mark each point by making a little circle round it with the pencil, thus ⊙

Many fall into a habit of punching holes in the paper with a view to making the marks conspicuous, and thus saving time in hunting for them; but it is a bad habit, as these holes mar the appearance of the drawing if they are in isolated places and not upon lines afterward inked in, and if they are, the ink is apt to fill the holes and spread out somewhat, making it necessary to draw a line wider than may be desirable in order to hide these spots.

But above all things, avoid the habit of using the dividers for taking measurements off the scale. It takes more time to set off a distance in this way, as it is more difficult to adjust the dividers than to set the scale down on the paper. This is one thing, but besides, we have seen valuable instruments utterly ruined by this vicious practice. The point of the dividers will scratch the surface if it slips, and if pressure enough be used to prevent this, it will gradually wear a hole in the wood if many measurements are taken from the same point. And this is very apt to be the case, because the distances thus set off are usually the fractional parts of a foot, and are therefore measured from the zero of the scale in every instance.

The adjustment of the pencil compasses sets another snare into which the unwary too often fall; it seems so natural to stick the needle-point into the scale, and take off the required radius, that many do this who would not use the dividers in the manner above deprecated. But it is not difficult, when the habit of it is formed, to put the scale down on the board and stick the needle point into the paper beside it, instead of into the scale itself, or else to mark off the required radius on the paper with the pencil, and adjust the compasses by that.

In either case, it is important to remember that it will not do to trust to this setting without testing, which is done by striking two short arcs, diametrically opposite to each other, and applying the scale to see that the *diameter* is correct. This should always be done on the edge of the sheet or on a separate bit of paper, before the circle is drawn in the intended place.

Care should also be taken to preserve the edges of the scale from injury, and it is a good plan to keep it in a box of proper form and size when not in use; this is particularly true in regard to the triangular instrument, which, having always an edge upward when lying on the board, is more liable to accident than the flat one. By due attention to these hints, and recollecting also that the scale is not intended for a ruler, and should not be used as one, the instrumentmay be kept in perfect order for years. Let us suppose that on a given right line we wish to set off from one point to another 3 inches, from that to the next 5½, then 2¼, and finally 4½. We will often see these distances set off separately from point to point; the 3 inches being marked off first, the scale will be shifted, so as to set the zero at the second point, and the 5½ inches then marked, and so on to the end. This is a bad method; in the first place it wastes time, as the scale has to be moved and adjusted for each measurement. But worse than this, the result is not likely to be accurate; there is a possibility of making a minute error in setting off any measurement, and although it is possible that these errors in the supposed case may balance, an excess in one case being offset by a deficiency in another, we have no assurance to that effect, and if these errors happen to be all of one kind, the sum total of them may be quite perceptible, so that the whole distance laid off may not be equal to the aggregate length of the various parts.

The proper way is to set the zero of the scale at the place of beginning, and keep it there; then mark off in succession 3, 8½, 10¾, 14¼. Of course, even this will not ensure absolute precision, nor do we know that anything can. But at least we gain this advantage, that the error in the measurement from the point of beginning to any one of the points marked off, will be no greater than that which is liable to occur in setting off any distance whatever, as we avoid the possibility of cumulative inaccuracies, which is involved in the other mode of proceeding, and we save time.

As a continuation of the practice in drawing curves constructed by points, we give in Fig. 4 another of the numerous family of spirals. Like the Archimedian spiral, given in Fig. 179 of the preceding series, this curve is generated by the motion of a point which revolves about the fixed centre or pole P, and at the same time moves radially away from it. But the radial motion is accelerated while the circular motion is uniform, and the law of this acceleration is such, that the radiants which make equal angles with each other are in continued proportion. Thus EP, PG, PC, PI, etc., make equal angles with each other, and we have

$$EP : PG :: PC : PI :: PA : PH :: PD : PK, \text{ etc.}$$

But since the angle EPG is equal to the angle GPC, the same law will give us EP : PG : : PG : PC; that is to say, if we bisect the angle between two radiants, the central radiant will be a mean proportional between the other two. So, if we consider EPA as an angle of 180°, CP perpendicular to EA bisects that angle, and we have CP a mean proportional between EP and PA. We see also that

$$EP : PA :: CP : PD :: PA : PB, \text{ etc.}$$

Now, we can find a mean proportional between two given lines by the graphic method illustrated in Fig. 5. Let AB be the greater, BG the less; draw the right line AG equal to their sum, bisect it at D, and describe the semicircle on AG as a diameter; erect the perpendicular at B cutting this semicircle at E, then EB is the required line. For if we draw AE, EG, we shall have two similar triangles, AEB, BEG, which give

$$AB : BE :: BE : BG.$$

In constructing the spiral, we may have any proportion we please between AP and PB, for instance; then bisecting AB at F, describing the semicircle, and drawing PD perpendicular to AB, we have A, D, B, as three points in the curve. Bisect the angle APD, and lay off PH, a mean proportional between AP and PD, then H will be another point. So also PK bisects the angle BPD, and is a mean proportional between PD and PB.

In a similar manner we may find any number of points between A and B. But if we assume AP and BP, as we have here supposed, we should yet be unable, by this construction, to find PC, for instance. We know, however, that PB : PA : : PD : PC; and the problem then is to find a fonrth proportional to three given lines. The graphic method of doing this, which will be found very useful in a great many cases beside this, is shown in Fig. 6.

Draw two right lines making any angle whatever with each other at P, on one of them set off PB, PA, on the other set off PD. Draw BD, and through A a parallel to it, cutting PD in C, then by similar triangles we have

$$PB : PA :: PD : PC.$$

That is, PC is the required radiant; in a similar manner we may find the length of PL, and so on for as many radients as may be required.

The student will readily see that if PA be made a half, a third, a fourth, or any aliquot part of PB, the lengths of the radients PG, PC, PI, PL, may be very easily determined by the use of dividers. He will find it good practice to draw a variety of these spirals, using a different proportion in each case between PB and PA; the curve, which is known as the logarithmic spiral or the equiangular spiral, is one which may subsequently reappear in a practical application.

EGGS.

THE nutritive value of eggs, and the cheapness of their production, is scarcely realized by the public. It may seem rather improbable to state that when meat is 25 cents a pound, the food value of eggs is about 37½ cents a dozen, yet this seems to be the fact.

A dozen of average-sized eggs may be assumed to weigh a pound and a half. If we calculate the food values of meat and eggs as force producers—that is, the amount of work the pound oxidized in the body is theoretically capable of producing, we have 990 foot tons for the pound of lean meat, and 1584 foot tons for the pound of eggs. As flesh producers, a pound of eggs is about equal to a pound of meat, as the following analysis will show:

1 POUND OF EGGS.

Water	12 oz., 36 grs.
Albumen	2 oz
Extractive	130 grs.
Oil or fat	1 oz., 214 grs.
Ash	28 grs.

Will produce on the maximum 2 oz. of dry muscle or flesh.

1 POUND OF BEEF.

Water	8 oz.
Fibrine and Albumen	1 oz., 122 grs.
Gelatine	1 oz., 62 grs.
Fat	4 oz., 340 grs.
Mineral	350 grs.

—*Kensington Museum Catalogue.*

A hen may be calculated to consume one bushel of corn yearly, and to lay 12 dozen or 18 pounds of eggs. This is equivalent to saying that 3.1 pounds of corn will produce, when fed to this hen, 1 pound of eggs. A pound of pork, on the contrary, requires about 5½ pounds of corn for its production. When eggs are 24 cents a dozen, and pork is 10 cents a pound, we have the bushel of corn fed producing $2.88 worth of eggs, and but $1.05 worth of pork.

Judging from these facts, eggs must be economical in their production and in their eating, and especially fitted for the laboring man in replacing meat.

POULTRY FERTILIZERS.

A Belgian farmer states from experimental knowledge that the several domestic fowls produce yearly of air-dry excretions the following amounts:

One pigeon	2 to 3	kilogrammes.
One chicken	5 to 6	"
One duck	8 to 8½	"
One goose	11 to 11¼	"
One turkey	11 to 11¼	"

A kilogramme equals 2 pounds 3 ounces.

Some of our own poultry keepers place the figures at one bushel for each fowl yearly, at 40 pounds per bushel. This is doubtless too high. Others, to our knowledge, have saved three barrels of air-dry droppings, weighing about 100 pounds per barrel, from a flock of 30; considering the loss when running at large, this is probably only about half the whole amount, but nearer the correct average amount saved in practice.

From the data thus given, we may estimate by approximation the value of ordinary hen manure to range from 75 cents to $2.25 per hundred pounds (allowing for a loss of two thirds of the water of the fresh excretions), or $15 to $45 per ton, and 10 cents to 30 cents a year for each fowl. The higher figure equals in value many of the ammoniated superphosphates, which it resembles in composition, though not up to Peruvian guano, yet certainly worth saving by the poultry keeper. The higher figure is not far from the value of the manure produced by our grain-fed fowls.—*Scientific Farmer.*

A TEST OF POTATOES.

IN order to thoroughly test the relative merits as to cropping qualities of several different varieties of new potatoes lately introduced to the public with those of established character, I, on the 8th day of May last, made a planting of eight hills of the several different varieties hereinafter named. The soil was all the same—a rich sandy loam. No manure was used. The tubers were cut to single eyes and planted one eye to the hill. The care was the same in every particular. At digging I selected four hills of each variety, with the following result when weighed:

Variety.	*Lbs.*	*Variety.*	*Lbs.*
Burbank Seedling	18	Superior	12½
Hawley	10	Fortune	12½
Mahopac Seedling	8	Early Eclipse	8
Snowflake	12¼	Morning Glory	10
Early Ohio	15	Berlin Seedling	14
Irish Cup	14½	Alpha	9
Eureka	17¼	Ruby	16
Western Kidney	10¾	Carpenter's Seedling	7
Early Nonesuch	15	Ice Cream	6
Iowa Nonesuch	16½	Paragon	5
Seedling 10½	17	Calcutta Seedling	7¼
Seedling 6	15¾	Climax	8
Curiosity	11	Early Rose	6
Dunmore	9	Early Vermont	8½
Devenport	8¼	Peerless	10
Compton Surprise	13	Brown's Seedling	12
Seek No Farther	12	Early Favorite	6½
Early Wide-awake	10	Campbell's Late Rose	5
Success	11¾	White Peachblow	8
Victor	16		

Owing to the ravages of the locust in August the yield was not large, but the figures show the relative merits of each as to cropping qualities.

I also made the following test with and without fertilizers of the same varieties. Eight hills were planted to test each way with four selected and weighed.

	Lbs.
1. Without fertilizers	9
2. One tablespoonful of salt sprinkled at roots after hilling	10
3. Compost of one part salt, five unleached wood-ashes, a large handful placed on each hill after hilling	12¾
4. One part salt, five ashes and three of decomposed hen manure—one handful to each hill as above	21

I also made the following trial concerning the cutting of the seed. I planted ten hills of the same variety, prepared in the following four different ways:

1. Planted ten whole tubers, medium size, one to each hill.
2. Cut medium-sized tubers into four parts and planted one set to the hill.
3. Cut to single eyes and planted an eye to the hill.
4. Cut one eye into ten parts and planted one of these small sets to the hill.

The result of each of the ten hills was:

	Lbs.
Whole tubers	20
Quarter tubers	25
Single eyes	33
One eye divided into ten parts	22½

It will be seen that salt, ashes and hen manure combined, gave a yield of more than twofold than where no fertilizer was used, and also that the single eye gave the best returns of any method of cutting the seed.—*Corr. N. Y. World.*

WATERED LARD AND ITS DETECTION.

THERE is considerable complaint in some quarters of adulterated lard being crowded upon consumers, and circulars have been issued recently by Chicago houses charging this fraud upon Eastern refiners. There are doubtless some of the small refiners engaged in the production of adulterated lard, but the most of this sort of wash that is put upon the market comes from the Southwestern refineries. In order that dealers may know how to test this spurious article we subjoin directions for making a simple test for water: Take a clear glass bottle, fill it with the lard to be tested (leaving out the cork); place this bottle about six inches from the stove or fire, and let the lard slowly melt, being very careful not to get it up to the boiling point, as the water would then evaporate; most of the water will slowly fall to the bottom of the bottle, and the lard now melted will rise to the top. By glancing at the amount of water now deposited at the bottom of the bottle, as compared with the amount of oil (or lard) above it, you can easily tell about how much water there is in the fraudulent article. Should the lard not settle clear, nor precipitate much water, it is an evidence that it is also adulterated with alkali, which serves to combine a part of the water with the lard, making soap of it, which does not precipitate readily with the water.—*Grocer.*

ADULTERATION OF PEPPER.

A RECENT paper by a well-known French chemist, Professor Edouard Landrin, contains a useful *résumé* of this subject, which, the writer observes, has acquired increased importance owing to the prevalence of adulteration in France, since the alterations in the tariff consequent on the war of 1870. The Professor remarks that the active properties of the condiment are due to the presence of an acrid resin, together with a volatile oil and crystallizable substance known as *piperine*, but analyses of peppers by various eminent chemists exhibit considerable discrepancies in the relative proportions of their constituent principles.

With a view to ascertain the extent to which adulteration is now carried in Paris, the Professor himself purchased seventeen packets of white and as many of black pepper from retail dealers in Paris. Each packet contained from twenty to thirty grammes (three quarters of an ounce to an ounce) of pepper. Of the seventeen samples of black pepper, not one was pure—two contained flour (bean, pea, etc.), six refuse of all sorts in the shape of sweepings, two grains of paradise, three starch and potato meal, three olive kernels, and one vermicelli dust. Of the seventeen samples of white pepper, four were found pure, four contained starch, one grains of paradise, one mineral substances, three flour, one vermicelli dust, one biscuit dust, and one olive kernels.

GREEN HAY.

THE old method of making hay was to let it lay out several days and keep it continually stirring until it was thoroughly dry, and had more the semblance of chips than grass. The improved practice is to cut with a machine, ted it a few times, and draw it to the barn the same day. If such wilted grass is not allowed to get wet, it is found to keep quite as well as the former dried hay; especially is this case where the barns are comparatively tight. Recent experiments are reported, in which the freshly cut grass—cut after the dew was off—was allowed the sun but a couple of hours, during which the tedder went over it once, and was then raked up and housed in a building, clapboarded, tight beneath, plastered inside, and with slight ventilation, which was at once closed tight and not opened till winter, when the grass came out fresh and bright as the day it was put in. A farmer on the Berkshire hills had a short hay crop, which he determined to make go as far as possible. His barn was well sheathed, without cracks. The grass was all cut early, just before blossoming, and housed the same day as cut. While carting the hay the barn doors were kept closed, save to admit the teams, which were unloaded with the doors shut. Access of air was prevented so far as possible thenceforth. The hay was closely packed in the mows. The testimony of the farmer and all his neighbors is, that this crop of hay was brighter and fresher the next winter, and was more nutritious—the cattle eating less of it—than any previous crop. We might cite numerous similar examples. There is nothing in this contrary to science or sense. The over-heating of hay will only take place by the action of the oxygen of the air in the presence of moisture. Remove either and the heating will not occur. Remove the moisture and the grass becomes dry hay, less digestible, and minus some of its nutritive and aromatic qualities. It is better economy to keep out excess of oxygen, and have cured grass for fodder. There is a great saving of labor too in housing hay the same day as cut, which of itself is a strong argument for the system. Every wetting by dew, every hour's sun after the grass is wilted, lessens the value of the fodder. We can take advantage of the idea by providing tight barns, and keeping them closed until the hay has gone through its "sweat," which is a slight fermentation, which drives off excess of moisture without injury to the hay, if excess of oxygen is not permitted in the mean time.—*Scientific Farmer.*

CALCULUS IN HORSES.

WE lose a considerable number of valuable horses every year by this terrible disease, particularly those devoted to labor in the iron districts, which animals are generally very fine and powerful, and highly fed. One of my relatives has lost in this way no less than five splendid horses within a short space of time, and millers' horses are very liable to the disease both here and on the Continent. The calculi are formed in the large intestine (cæcum).

The points to which I wish to call the particular attention of veterinary surgeons and others are these:

1. That the calculi are owed almost entirely to phosphate of ammonia and magnesia.

2. That this salt is contained in the corn; and here arises the question whether *corn* is not for the horse as artificial a food as *meat* is for the human race.

3. The ease with which these calculi can be decomposed, broken up, dispersed, or dissolved by means of weak hydrochloric acid.

I am of opinion that repeated doses of very dilute hydrochloric acid, say 2 to 5 per cent, in water or spirit, if it can be made to reach them, would destroy the largest of these calculi in a comparatively short space of time. This treatment, with appropriate diet, would, I feel convinced, prove effectual even in very bad cases.

The disease no doubt originates from the cæcum becoming alkaline instead of remaining slightly acid as it should be in a normal state of health; the calculus itself is alkaline, and contains minute quantities of carbonate of ammonia and tribasic phosphate of magnesia, as well as the phosphate of ammonia and magnesia which constitutes the greater part of it. It is a very rapid disease; when once started a few years will find it increased very considerably. To cite one instance that has come under my own observation, a fine cart-horse was born in Hereford, where it remained four years, and then went to Staffordshire, where it lived five years longer. It died of calculus at nine years of age, and the calculus was 20 inches in circumference—the size of an ordinary gas-lamp globe—and weighed 8 lbs., so that it must have increased at least about 1 lb. a year, perhaps much more.

The lime in the water drunk by horses, to which some have attributed the disease, has nothing to do with it. It originates in the food—in the corn—as I have stated above, and is due no doubt, *in great measure, to a want of salt in the food.* When horses are highly fed for labor in the industrial districts, it is essential that they should have access to lumps of salt to lick, or have salt in their food and a liberal supply of water to drink. The ventilation and drainage of the stable is another important consideration. How many valuable beasts after a hard day's work pass the night in an atmosphere loaded with fumes of ammonia!—T. L. PHIPSON, Ph.D., F.C.S., etc., in *Chemical News.*

THE DEVELOPMENT OF THE HOUSE-FLY.

MR. A. S. PACKARD, JR., in the *American Naturalist*, after describing the different methods adopted by him to secure an abundance of the ova, goes on to describe a mode of exposing manure, which seems to have been very successful. Then he says: "The egg of the house-fly is long, slender, cylindrical, and a little smaller at the anterior end than at the other. It is .04 - .05 of an inch long, and about one quarter as thick. The shell is so dense that the early embryonic phases could not be watched, but enough was seen to enable us to determine that the mode of growth in the egg is nearly the same as that of the flesh-fly, as observed by Dr. Weismann. The eggs thus laid were found to hatch twenty-four hours later. In confinement they required from five to ten hours more, and the maggots hatched in confinement were smaller than those reared from eggs deposited in warm manure. Certain worms reared also in too dry manure were nearly one half smaller than those bred in more favorable circumstances. For several days the worms living in this dry manure did not grow sensibly. Too direct warmth, but more especially the want of sufficient moisture, and consequently of available semi-liquid fluid, seemed to cause them to become dwarfed. It is evident that heat and moisture are required for the normal development of the fly, as they are formerly all insects. The maggot moults twice, consequently there are three stages of development, and it becomes sensibly larger at each stage. After remaining in the first stage for one day it moults, and differs from the preceding stage only in being a little larger, and in the addition of the spiracle near the head. After remaining in this stage from twenty-four to thirty-six hours, it sheds its skin and enters upon the third stage, which lasts three or four days. The body is long and slender, somewhat conical, the head and mouth-parts being rudimentary. The end of the body is truncated, and bears two short tubercles or spiracles. If we enlarge one of these circular breathing holes we may see three sinuous openings, the edges of which are armed with fine projections, forming a rude sieve for the exclusion of dust and dirt. With these spiracles connect the two main tracheæ, communicating by two cross branches and sending off numerous twigs. The young of the house fly differs chiefly from that of the flesh-fly in being only one half as large, while the form of the openings in the spiracles at the end of the body is entirely different. When about to transform into the pupa or chrysalis state, the body contracts into a barrel-shaped form, turns brown and hard, forming a case (puparium), within which the body of the larva transforms into that of the pupa. Weismann has made the discovery that in the larval flesh-fly, when about to transform into the pupa state, the head and thoracic segments die, and that the head and thorax of the pupa arise from minute disks attached to the smaller nerves or tracheæ in the body of the worm. This is paralleled by the metamorphosis of the 'pluteus' into the adult star-fish, and is a much more complete metamorphosis than even that of the caterpillar into the chrysalis of the butterfly. Our house-fly having as a maggot lived a life of squalor, immersed in its revolting food, with its new change of form, involving the death of one half its body and the origin of a new head and thorax, with legs and wings, eyes, feelers, and mouth-parts, after a short pupal sleep of from five to seven days, pushes off one end of its pupa case, and appears winged, with legs where before there were no traces of feet, and is animated by new instincts and mental traits. It is difficult to realize how striking are the changes, physical and psychological, which the house-fly undergoes in the transition from the maggot to the volant, cursorial being."

THE ROOTLET HAIRS OF PLANTS.

MR. B. C. HALSTEAD, in a late number of the *Gardener's Monthly*, states that the largest portion of the liquid used by the growing plant makes its entrance through the roots, from the soil, is a well-established fact; but those parts which are the most active in the absorption of this food material in solution were for a long time not so clearly understood. By careful experiments and microscopic investigation, it is found that the extreme tips of young roots are about the only portion which take little or no part in this work. A short distance back from the growing points, on nearly all growing roots, may be seen with the aid of a microscope a large number of minute, slender bodies, extending out in all directions from the surface of the root. These thread-like structures are not inaptly called root hairs, and consist of sac-like protuberances, as outgrowths from the epidermis or surface cells of the root. With the naked eye they are not easily seen; but their presence may be inferred from the manner in which they cling to the particles of the soil when a young root is lifted carefully from the earth in which it was growing. This power, which they have of fixing themselves to the grains of earth, is very great; so that, when a plant is taken violently from the soil, large portions of these delicate hairs are broken from the roots, and retain their attachment to the soil. As the root grows along in the earth, new hairs are produced, while those behind perish as the root becomes woody, and a dense, non-absorbing, protecting epidermis is formed; so that the active life of a single hair is of short duration. The office of these hairs must have already suggested itself to the reader. By means of these prolongations, the greater part of the absorption takes place, though the newly-formed surface cells are also active.

VILLAGE DRAINAGE.

LENOX, Mass., is being drained by a system of small, six-inch, tight sewer pipes, which lead from the houses along the streets to a large tank in the open fields. This tank has a capacity of three to four thousand gallons, and is self-acting in that it will empty itself, by means of a syphon, into a system of distributing drains some ten thousand feet in united length, laid at a depth of one foot beneath the surface of the ground. The distributing drains are porous land tile, laid with open joints, so that the sewage is absorbed into the soil, which is enriched thereby and fitted for the growth of grass and similar crops. Provision is made for disposal of the sewage by surface irrigation at any time when freezing might prevent the working of the sub-irrigation, though in similar systems in use in the North it has been shown that the sewage keeps the soil warm enough to prevent freezing in the immediate vicinity of the drains sufficient to absorb all the sewage. It is said that this system is perfectly odorless, and examinations of the soil receiving the sewage for six years have failed to show any accumulation of filth. An essential part of the system is that beside the sewer pipes leading to the reservoir tank are laid land tile to provide for the drainage of the land. At stated intervals are tumbler tanks which receive the clear water from the tile, and discharge when full, by automatic action, into the sewage pipes, thus cleansing them with a rush of clear water and preventing the deposition of sediment. This is the patented system of Mr. Rogers Field, a leading sanitary engineer of England, who, however, waives his right of royalty in favor of Lenox, as this is its first introduction to this country. Col. Geo. E. Waring has charge of the work, for which he is well fitted by his travels, study, and experience.

RAT AND MICE PROTECTOR.

A. J. WILLARD, of School House Station, San Mateo County, California, gives a very simple, and, in his experience, a very effective safeguard against rats and mice. He takes two round pieces of tin, like the bottom of a fruit can, punches a hole in the centre of each piece, and strings them on a strong wire, one near each end. Then he stretches the wire from side to side of a room and fastens each end firmly. Any thing which is hung upon the wire between the plates of tin is safe from the rats, for if they walk out upon the wire, every time they try to mount the circle of tin, it revolves and they cannot pass over it. Mr. Willard has found the simple contrivance very useful in saving meat, grain, etc., and advises all farmers to try it.

HOW TO SOFTEN HARD WATER.

RAIN WATER contains a small amount of carbonic-acid gas, and when such water runs over limestone it dissolves and holds a small quantity of carbonate of lime, and becomes what we call "hard water." To convert it into soft water we must get rid of this carbonate of lime; and this may be done, in cisterns or reservoirs, by pouring in lime water, which by combining with the excess of carbonic acid causes all the lime to precipitate in the form of an insoluble carbonate, which falls to the bottom.

NEW MASH FOR HORSES.

THE Brabant Journal of the Agricultural Society recommends very highly a mash for horses made of 3 parts by weight of bran, 4 of oats, and 36 to 48 of flaxseed. Boiling water is first poured upon the oats and flaxseed in a bucket, and the bran then added, and the vessel covered with a woollen cloth, and allowed four to five hours to cool.

REMEDY FOR VERBENA RUST.

ROBERT PALMER says, in the Gardener's *Monthly*, that pulverized charcoal applied to spots of rust removes them in a short time. He has tested its merits on some pretty hard cases, and always with success.

OIL OF THE SMUT OF CORN.

PROF. C. LOMBROSO reports a case of chloasma of the forehead and cheeks, of a year's standing, which he treated on one side with red oil from the smut of corn, and on the other with rancid oil from sound corn. The former proved much the more efficacious, removing the patches after three days' use, but the unpleasant effects on the system at large made the patient unwilling to resume its use. The same remedy effected the cure of a patch of eczema on the chin of an insane patient in five days.—*Centralbl. f. d. Med. Wiss.*

STATISTICS OF TOBACCO-SMOKING.

THE following table gives for each country named its consumption of tobacco per annum per 100 inhabitants: Belgium, 250 kilogrammes; Holland, 200; Germany, 250; Austria, 124.5; Norway, 102.5; Denmark, 100; Hungary, 94; Russia, 83.3; France, 81; England, 62; Italy, 57; Spain, 49; Sweden, 34 kilogrammes. From this it seems that France (in a revenue point of view) does not smoke enough. When she attains the position of Belgium in this matter the tobacco impost will return 896,000,000 fr. to the exchequer, instead of its present 3,000,000 fr.

NEW VARIETY OF LIQUORICE.

A NEW and superior species of liquorice, of Italian origin, has made its appearance in the European (St. Petersburg) market. It occurs in shapeless masses, is somewhat tough, capable of being cut with a knife, and of a purely sweet taste, free from empyreuma. On dissolving it in water, it leaves only a trifling residue, and when dried at 90° C. yields 75 per cent of dry extract.

A CRYSTALLINE COATING FOR PAPER OR WOOD.

PROFESSOR BÖTTGER recommends the following recipe for this purpose: Mix a concentrated cold solution of salt with dextrine, and lay the thinnest possible coating of the fluid on the surface to be covered by means of a broad, soft brush. After drying, the surface has a beautiful, bright mother-of-pearl coating, which, in consequence of the dextrine, adheres firmly to paper and wood. The coating may be made adhesive to glass by doing it over with an alcoholic shellac solution. The following salts are mentioned as adapted to produce the most beautiful crystalline coating: sulphate of magnesia, acetate of soda, and sulphate of tin. Paper must first be sized, otherwise it will absorb the liquid and prevent the formation of crystals. Colored glass thus prepared gives a good effect by transmitted light.

RUSSIA LEATHER.

BIRCH-OIL is made by distilling 20 pints of birch bark with one of Ledum palustre, crammed in layers into an earthen pot, with a handful of tripoli betwixt each layer. The mouth of the pot is closed with a perforated oaken plug, and being inverted is luted to the mouth of another pot sunk in the ground. The upper pot being then surrounded by fire, a brown empyreumatic oil is distilled *per descensum* into the lower jar. An eight-gallon pot, properly filled, yields from 2 pounds to 2½ pounds of oil. In Siberia it is prepared without the Ledum, which imparts a rosy smell. This oil is liquid when fresh, but grows thick in time. It is used for currying the well-known Russian leather, and might profitably be more variously applied. It is infallible against dust and insects.

SOAP OBTAINED DIRECTLY FROM SALT.

IF tallow, oil, and resin, the matters commonly employed in soap-making, are heated with an excess of common salt, ammonia, and water, a soda-soap separates, leaving in the liquid chloride of ammonium along with the excess of free ammonia and salt. This reaction is due to the greater solubility of ammoniacal soap in ammoniacal water, and the insolubility of soda soap in water containing ½ per cent of salt. At first the ammonia combines with the fatty acids, then the sodium contained in the salt takes the place of the ammonia in the soap. An excess of ammonia and soap is essential. 100 parts of tallow require 15 or 20 parts of ammonia, 30 to 30 of salt, and 200 to 300 parts of water.—WHITELAW in *Chemischen Centralblatt.*

INCOMPRESSIBILITY OF SAND.

EXPERIMENTS made in 1869 by M. Baudemoulin at the Conservatoire des Arts et Métiers established, (1) The almost absolute incompressibility of sand. (2) That it has the property of forming a semi-solid, semi-fluid body, so that it will flow through an orifice, yet not in the form of a jet. (3) That it does not transmit pressures laterally. (4) That it will pass through an orifice with a *constant* flow wholly irrespective of the superincumbent pressure. That sand transmits no pressure laterally, was proved by the fact that sand did not pass through an orifice measuring nearly half an inch in diameter, closed simply by a piece of tissue-paper held in place by a piece of cotton thread, although it was at the time subjected to a pressure of more than eleven tons. These statements being accepted as facts, it is suggested that sand may become a very valuable building material, as double walls of the thinnest boarding with a core of dry sand become at once, owing to this property of the non-transmission of lateral pressure, as stable as if bricks had been used in place of boards, provided the pressure is maintained always vertical. Sheet-iron casings, filled with sand, will at once become serviceable as columns and piers.—*Am. Arch. and Build. News.*

WATER BENEATH GLACIERS.

MR. CHARLES KNIGHT, in the *Philosophical Magazine* for June, states that, according to Professor William Thomson's experiments, the freezing point of water is lowered 0.23° F. for each additional atmospheric pressure; and that, hence, if a glacier have a thickness of 3000 feet, the pressure would be about 80 atmospheres, and under this pressure the temperature at the base should not exceed 13° F. to retain the solid form. The statement needs a correction, since Professor William Thomson's experiment made the lowering of the freezing point of water 0.23° F. for *sixteen* atmospheres of pressure. This would give for 80 atmospheres, supposing the increase by arithmetical ratio, only 1.15° F.

BARIUM.

AMONG the curiosities of a chemist's cabinet are usually to be found small specimens of the metals of the alkaline earths, barium, strontium, and calcium. Covered with a dirty brown crust, they lie on the bottom of a little bottle of naphtha, looking like any thing but the bright, lustrous metals which we find them to be when we scrape or cut them. The difficulty of preparation, notwithstanding their abundance, has made them so expensive as to preclude their finding any useful application in the arts.

In 1808 Davy obtained metallic barium electrolytically. Baric carbonate or hydrate was mixed with water to a stiff paste and placed on a piece of platinum foil, connected with the positive pole of his powerful battery of 500 pairs. A hollow made in the paste was filled with mercury and this connected with the negative pole. The metal, as fast as it separated, combined with the mercury, forming an amalgam. From this amalgam the mercury was expelled by distillation in a current of hydrogen.

Bunsen improved on Davy's method of obtaining this amalgam by using baric chloride, which he mixed with water slightly acidified with hydrochloric acid, and placed in a carbon crucible forming the positive pole of a battery. The crucible was heated to 100° C., by placing it in a water bath. An amalgamated platinum wire, forming the negative pole of a battery, dipped into the mixture. In a short time the wire became covered with a silver-white, crystalline crust of barium amalgam. In moist air this amalgam is rapidly decomposed, heat being evolved and baric hydrate formed. For this reason it is at once introduced into a carbon boat and heated in a current of dry hydrogen gas, when the mercury is expelled, leaving the barium in the form of a dark-colored, swollen, and lustreless mass, frequently exhibiting a few silvery surfaces in the interstices or air cavities.

Barium can be prepared, as was first shown by H. Davy, by the action of potassium vapors upon baric oxide or chloride. Regnault's method consists in placing the baryta in a platinum boat in a gun-barrel open at both ends. At a short distance from the baryta he places some pieces of potassium, and then dry hydrogen gas is passed through the gun-barrel. When the air has been completely driven out, the baryta is heated to redness, the potassium is volatilized and the barium reduced. Hydrogen is still passed over it until cold, when the barium is dissolved out with mercury, forming an amalgam, from which the mercury is subsequently expelled by distilling in hydrogen.

Crookes states that barium is easily prepared by Böttger's method, namely, the action of sodium amalgam on a saturated aqueous solution of baric chloride. The solution is heated to 93° C., and the amalgam introduced; the barium and sodium then exchange places, forming sodic chloride and barium amalgam. The liquid is poured off and the amalgam again treated with baric chloride solution. After decanting the solution again, the amalgam is kneaded under water to remove the salt, then dried and pressed through a cloth to remove excess of mercury. It forms a solid crystalline mass, which oxidizes slowly in the air. If the mercury be distilled off in a glass vessel the temperature must not exceed redness; else the barium will attack the glass.

S. Kern, of St. Petersburg, who has been experimenting with all these methods, finds them expensive and unsatisfactory, and recommends a new process of his own, in which baric iodide is decomposed by means of sodium. The first step is the preparation of the iodide. Iodine is dissolved at a moderate heat in baryta water, forming baric iodate and iodide; the former is converted into the latter by means of sulphydric acid gas, the solution filtered and evaporated, and the residue dried. This salt is now pulverized and mixed in equivalent proportions with sodium, and the mixture heated in a closed iron crucible. The reaction is accompanied with heat and light. The barium is extracted with mercury and freed from it, as in other processes, by distillation. Barium can be obtained in this manner in a compact form, but we do not anticipate its production on a large or economical scale yet, and the experimenter still has a fine field for work on barium.—*Boston Journal of Chemistry.*

AUTOMATIC CIVILIZATION.

EVERY DAY the world gets itself more and more thoroughly organized. Toward perfection in that respect the course of invention takes its way. This tendency of the time is well shown in the application of some professionals recently, who, to use the language peculiar to their art, "cracked a crib," and by the very operation of their jimmies and wrenches called the police, for as they opened a door they gave a signal at a neighboring station as effectually as a guest at a hotel calls a waiter; in fact, more effectively. Then the police came and captured the marauders in unconscious ignorance of the fact that they had informed on themselves. This contrivance, which may yet render detectives superfluous, starve out the receivers of stolen goods and lead to calamities in the lock trade, is but one feature in the modern physical organization of cities. Another ingenious apparatus carries its little thermometer into the great warehouses, and the thermometer watches and waits patiently all night every night in the year, and if a fire occurs the thermometer rises, rings a bell, calls the firemen, and the property is saved. In fact, a city becomes a living creature, and the men and women in it only atoms of a great aggregate organism. As when a human stomach becomes painfully empty a man's legs carry him to the nearest restaurant, so the telegraphic threads drawn under the streets and through the houses and over the steeples, like an intricate nervous system, connect part with part and associate every irritation with an impulse sufficient to overcome it—every evil with a remedy. There is no knowing to what wonders we may reach in this process of the exclusion of intermediate agencies, but there is every appearance that we may one of these days have merely to turn a crank and start into automatic activity the operations of such a municipal universe as this metropolis, just as Aladdin started his airy steed in the story.—*N. Y. Herald.*

ARCHÆOLOGICAL DISCOVERIES AT BONN.

AT Bonn, on the Rhine, on the occasion of the erection of a new building connected with the University, remnants of Roman houses have been found, showing signs of a conflagration—probably the result of a struggle between Germanic tribes and the foreign dominion.

On the wall of one of the houses there were beautiful frescos, which unfortunately broke in pieces when taken out. The picture represents an amazon on a horse, with a lance in her right hand; her mantle driven back by the wind. Near her there are some foot soldiers who, so far as can be seen, appear to parry her thrusts. The colors are well preserved. A bronze statue, representing a fine youth, probably a charioteer; a little votive altar, with a much mutilated inscription; a potter's oven, with many urns and tiles; numberless objects for everyday use—such as dishes; cups of black clay with an inscription in white; bottles large and small; buckles; dice; pencils in ivory or bronze, with ornamented tops; coins contained in urns of partly colossal dimensions, and many other things were dug up at the same time.

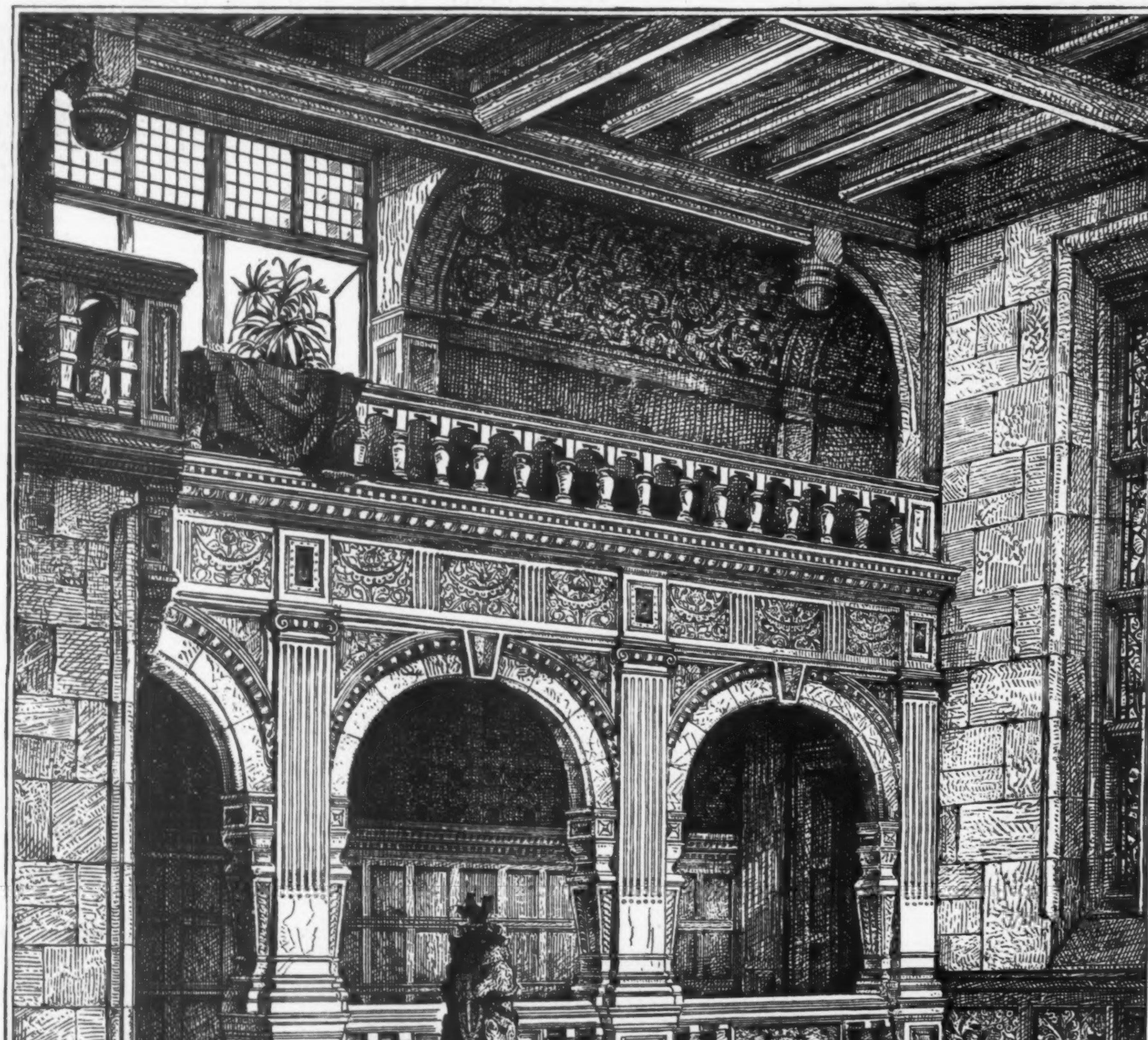
These discoveries have been made along an old, well-known Roman high-road. The excavations are still continued under the supervision of the Bonn Society of Archæologists, whose president is Professor Weerth. Many more interesting finds are expected.

FRICTION OF THE ETHER.

MR. W. M. HICKS drew the attention of the Cambridge Philosophical Society to some experiments of Messrs. Stewart and Tait on the heating of disks by rapid rotation in vacuo, and which they referred to the friction of the ether. He showed that it was not necessary to have recourse to this explanation, that nearly all the effects could be accounted for if it is supposed that the disk, through the rapid rotation, has expanded and consequently been lowered in temperature, that whilst rotating it is raised to the temperature of the surrounding region, and, therefore, when the rotation is stopped, and the disk has shrunk to its former size, it will give out the heat it had taken in whilst rotating. In the case of silver it was shown that the disk ought to show a rise of .4° C., if the rotation had been continued for some time, and this was compared with the rise of .47° C., which Messrs. Stewart and Tait had observed in an aluminum disk, thus showing that the effect was of the same order of magnitude in the two cases. It was also shown that if the whole heating were due to ethereal friction, that this friction would be .0006 lbs. per square foot, and that if we suppose this amount to act on the surface of the earth, the day would be lengthened in the course of a century by something like .006".—*Nature.*

NEW ZEALAND CRAY-FISH.

IN a paper in the *Annals of Natural History*, Mr. J. Wood-Mason describes an interesting structure, by means of which the young of the New Zealand cray-fish attach themselves to the mother. Indeed, it strikes us that the idea of the young being attached at all is decidedly a novel fact. Mr. Mason gives a magnified figure of one of the limbs of the young Astacoides, which shows us that at the extremity it is furnished with a peculiar hook-like process. This so firmly sticks in the mother, that Mr. Mason had to pull the young animal away without its limb in order to disengage it.



STAIR CASE IN THE JACOBEAN STYLE.

STAIR CASE, JACOBEAN STYLE.

IN continuance of our series of suggestions in Art designing we give a Staircase in the Jacobean style, for which we are indebted to the *Building News*. The author of this design is Mr. B. J. Talbert, of London, and the original drawing, which was exhibited this year at the Royal Academy.

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